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THE BATHYPELAGIC ANGLER FISH *CERATIAS HOLBÖLLI* KRÖYER

By

ROBERT CLARKE, M.A.

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THE BATHYPELAGIC ANGLER FISH *CERATIAS HOLBÖLLI* KRÖYER

By Robert Clarke, M.A.

(Plate I; Text-figs. 1–6)

INTRODUCTION

Bertelsen (1943) considers that the deep-sea angler fishes or Ceratioidea are, in some respects, the most peculiar and specialized of all fishes. They derive their name from *Ceratias holbölli* Kröyer, which is the largest species in the group and the fish from which Regan (1925*a*) first described dwarf-males. Yet of this fish only twelve specimens, several of them damaged, have been recorded since Kröyer erected the genus and species in 1844. Bertelsen gives a list of these, all of them from arctic or boreal-arctic seas.

Furthermore, Bertelsen has described the remarkable apparatus for extending and retracting the fishing lure in *C. holbölli*. His new interpretation of the structures involved led him to revise the systematics of the family Ceratiidae which Regan & Trewavas (1932) had divided into the three genera *Ceratias* Kröyer, 1844, *Mancalias* Gill, 1878, and *Cryptopsaras* Gill, 1883. Bertelsen concludes that *Mancalias* is invalid and actually comprises juveniles of *Ceratias*. Within the genus *Ceratias* he reduces the number of species to a northern *C. holbölli* and a southern *C. tentaculatus*.

The following account includes the description of a new specimen of *C. holbölli*. It is from Antarctic seas, and its oceanic origin makes it specially interesting, since the other adult individuals have been taken from neritic seas. Furthermore, it is the first large adult to be recorded from the southern hemisphere.

MATERIAL

During the Antarctic whaling season 1947–8 I was able to examine a number of Sperm Whales (*Physeter catodon*) on board the whaling factory ship 'Southern Harvester'. The stomach contents of these whales consisted principally of squid, but occasionally teleost fish were present. In a later account it is hoped to deal generally with the occurrence of fish in the stomachs of Sperm Whales.

The present paper refers repeatedly to a single adult female of *Ceratias holbölli* which was found in the stomach of Whale no. SH 156, Sperm ♂, 50·0 ft. (15·2 m.) long, on 21 December 1947. The whale was worked up very shortly after capture, the noon position of the factory ship being then 61° 20′ S, 102° 50′ E. The first stomach was full, containing many individuals of the squid *Moroteuthis ingens* Smith. On raking these over I found a large Ceratiid fish scarcely touched by digestive action and with the fishing lure intact. There were no other fish present.

The specimen was removed from the flensing deck and was measured and sketched whilst still fresh. The body cavity was injected with 10 % neutral sea-water formalin, and the fishing lure removed for safe transport before both fish and lure were fixed in formalin.

The fish has since been presented to the British Museum (Natural History) where I have been able to examine it further and to compare it with other Ceratiids in the national collection.

ACKNOWLEDGEMENTS

I am indebted to Messrs Christian Salvesen and Co., owners of the 'Southern Harvester', and to the master, Captain Konrad Granoe, for facilities afforded on board that vessel. I also wish to thank the Director and Trustees of the British Museum (Natural History) for working accommodation and for

access to the collection of fishes. Dr N. A. Mackintosh has extended helpful criticism and suggestions. Dr Ethelwynn Trewavas has kindly read the manuscript, and I owe especial thanks to her and to Mr N. B. Marshall for much advice.

DESCRIPTION OF AN ANTARCTIC SPECIMEN

In identifying the new specimen as *Ceratias holbölli*, and so extending the range of this species into Antarctic seas, I have been assisted by access to the individual* (67 cm. standard length) from which Regan (1925*a*) first described dwarfed males. This has supplemented comparisons with descriptions in the literature.

EXTERNAL CHARACTERS

Standard length 43·0 cm.

Weight 3580 g.

The general appearance of the fish (Pl. I) closely resembles a photograph (Bertelsen, 1943) of the specimen 65 cm. long, which has been briefly described by Saemundsson (1939). There were no dwarfed males attached to the new specimen.

The rays of the dorsal and caudal fins were more or less broken and lacked the distal portions of their integuments, as also did the exserted part of the basal bone of the lure.† Otherwise the specimen was intact.

Measurements of the fish expressed as percentages of the standard length are included in Table 1, together with those of Kröyer's type and Regan's 1925 specimen. In general they show good agreement, but the matter of proportions will be pursued later.

The spines which beset the skin are conical and with broad bases as described by Kröyer (1844) and Regan & Trewavas (1932). The largest are 0·3 cm. high and 0·4 cm. across the base. They are evenly distributed over the body surface, except for a naked area in front of the pectoral fin, extending from a point slightly above the fin forwards and downwards over the region of the gill-cover (Pl. I). A few small spines are scattered just below the lower jaw. In Regan's example the spines are more numerous, more closely set, and more extensively distributed over the body, but they are sparser on that part of the head which in the new specimen is naked. The largest spines are 0·6 cm. high and 0·9 cm. broad, and therefore not relatively larger than those in the new and smaller specimen.

The colour‡ in the head region of the new specimen is greyish black. More posteriorly, in the upper parts of the body and flanks of the tail, this greyish black colour is mottled with irregular dirty white patches. The belly is a dirty grey tinged with black. There is less pigment on the right side of the body than on the left, but this difference, and the mottled appearance, may be attributed to digestive action. The smooth or naked region of the head was steel blue when fresh, and the outlines of the branchiostegal rays beneath could be seen. The sparsely spinal area below the lower jaw is black. Four black streaks extend slantwise across the smooth area. The inside of the mouth, including the large tongue, is black, and so is the anterior border of the opercular opening. The body colour of Kröyer's type and Regan's specimen was blackish.

The mouth of the new specimen has a large gape of 130°, and the upper jaw (as in Regan's specimen) is rotated back 25° past the vertical. Vomerine and palatine teeth are absent—a character shared by all the Ceratioidea (Lutken, 1878). The teeth are confined to the dentary and premaxillary and are directed

* B.M. (N.H.) 1924. 12.29.1.

† This damage can at least be partly attributed to incipient digestion, although the fish was removed from the Sperm whale's first stomach which has no digestive lining and acts as a storage organ. Food in this stomach quite soon begins to be attacked by gastric juice, which presumably has been regurgitated from the second stomach during the convulsion following harpooning, or has leaked over after death.

‡ All observations on the colour are transcribed from notes made on the fresh specimen.

inwards. They are slender, sharply pointed and small, the longest measuring 0·4 cm. In the dentary, and especially near the symphysis, they tend to be arranged in two series, the inner series including the longest teeth. This character is contained in the synopsis of the family given by Regan & Trewavas (1932). The teeth in the premaxillary are mostly smaller, and there is less indication of a second series. The dental formula is $\frac{14}{15} \cdot \frac{11}{15}$. In Regan's specimen the shape and arrangement of the teeth are the same, and relatively they are the same size, the largest being 0·6 cm. in length. Their formula is $\frac{8}{24} \cdot \frac{8}{23}$. The difference in the number of teeth is not considered significant in the two specimens since, as Waterman (1939*b*) has pointed out, there are at present no data on the individual and ontogenetic differences in the teeth of Ceratioids.

The gill opening, in both the new and Regan's specimen, is an oval aperture immediately below and a little posterior to the insertion of the short peduncle of the pectoral fin.

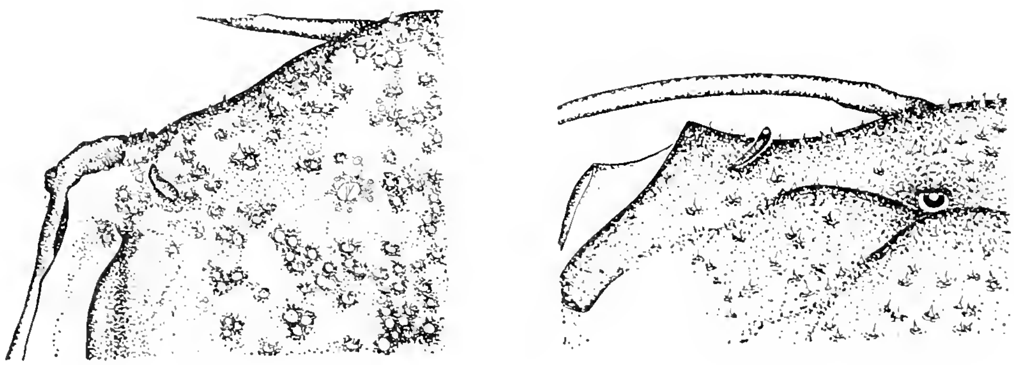
There is close correspondence between the fins of the new specimen and those of Kröyer's type and Regan's specimen. As in these the dorsal fin has four rays. There are no ventrals. The small pectoral fins have nineteen rays each in the new specimen and in Kröyer's type. Regan's specimen has eighteen pectoral fin rays. All three examples have four rays in the anal fin. Kröyer gives eight rays for the caudal fin of *C. holbölli*, and Regan & Trewavas (1932) also define eight rays for the family, Ceratiidae, although Lutken (1878) and Gill (1878) stipulate nine and Regan (1926) allows eight or nine. Beebe & Crane (1947) find an incipient ninth ray in some of their specimens of '*Mancalias uranoscopus*'. The caudal fins of the new specimen and of Regan's have eight rays and the four middle ones are forked (Regan & Trewavas, 1932). But the caudal of the new specimen, like that of Saemundsson's 1939 example (see Bertelsen, 1943), is damaged and does not possess the ribbon-like prolongations found in the type and in Regan's specimen.

Smallness of the eye has long been recognized as a character of deep-sea angler fish, especially the Ceratiidae (Kröyer, 1844; Lutken, 1878; Gill, 1878; Günther, 1887; Regan, 1912 and Waterman, 1948). In describing his monospecific genus *Typlopsaras*, Gill (1883) gives 'obsolete or no eyes'. *Typlopsaras* was included with *Mancalias* by Regan & Trewavas (1932) and has since been regarded as a juvenile *Ceratias* by Bertelsen (1943). Gill does not clarify these remarks on the eyes in his description of the single specimen *Typlopsaras myops*. The eyes of the new specimen, besides being small, are especially interesting because they are subcutaneous. In the region where one would expect to find the eye there is a ring of black pigment, stippled with minute spines. This ring encloses a small circular area, 0·4 cm. across, where the skin is transparent and forms a kind of eyeless window. When first examined two small blood vessels could be seen to cross its floor (Fig. 1A). The eye itself is completely concealed below the normal opaque skin, in a position immediately dorsal and adjacent to the pigmented ring; it may be exposed by an incision. Undoubtedly the specimen was functionally blind. I have found that the eye is also subcutaneous in Regan's specimen, although he has apparently overlooked this in his very brief accounts of the fish itself (1925*a*, *b*, 1926), being naturally preoccupied with dwarf-males. As would be expected, his photograph of a cast made from the specimen (1925*b*) shows no trace of the eye. In Regan's specimen the disk of transparent skin surrounded by a ring of pigment is not to be found. The figures of Kröyer's type displays a small eye (Gaimard, 1842–56, *Poissons*, pl. ix). Bertelsen's text does not mention the eyes in the two specimens he describes, but no eye is visible in his photograph of Saemundsson's 65 cm. example. Significantly enough, the eye may be discerned in his much smaller 18·5 cm. specimen recovered from west Greenland in 1880. This matter of the eye will be discussed later (see p. 15).

Nostrils have not previously been described in *Ceratias*. They are present as much reduced structures

in both the new specimen and that of Regan, and they have a very similar appearance in both. They are small tubular nostrils, and take the form of a pair of flattened, somewhat elongate sacs, each opening by a small pore, and appearing as a tag of black skin, 0·9 cm. long, a little above the level of the eye and just behind the distal end of the maxillary (Fig. 1A).

The lateral line system of the new specimen has been followed only in the head region, where it forms a curving line of small black papillae arranged in a single, regularly spaced row. It begins at the tip of the lower jaw and runs downwards and backwards to curve up again and extend half-way across the smooth region of the gill covering. A little distance from its beginning on the lower jaw, the lateral line sends a short branch, with relatively few papillae, as far as the articulation of the jaw (Pl. I). The older authors (Lutken, 1878; Gill, 1878) have denied the existence of a lateral line among the Ceratioidea. Günther (1887) mentions pores, scattered over the skin of '*C. uranoscopus*' and '*C. carunculatus*', which secrete luminous mucus; these may be referred to the lateral line. Later, Regan & Trewavas (1932) described the various modifications of the lateral line organs of Ceratioids, and classified the Ceratiidae



A B

Fig. 1. *Ceratias holbölli* Kröyer. Upper part of the head showing the eyes and nostrils. (In the Antarctic specimen the eye is subcutaneous; its position is indicated by a pecked circle above the 'eyeless window'.) A. Antarctic specimen, × $\frac{2}{3}$. B. '*Mancalias bifilis*', × 12.

with four other families as possessing 'organs on stalks'. Each papilla of the new specimen is a flattened tag with a broad, pear-shaped outline. The tip bears the white organ mentioned by Regan & Trewavas. This form, although nearest to the 'organs on tags', does not fit any category of their classification. Waterman (1939*b*) was likewise unable to classify the tagged lateral line organs of his small holotype of *Gigantactis longicirra*. It is possible that the form of the papillae in the various genera may undergo ontogenetic changes of which the classification takes no account. No superficial groove or subcutaneous canal could be found connecting the papillae in the new specimen. The special significance of the lateral line in *Ceratias* will be discussed later.

The anus and urogenital aperture of the new specimen open upon an area of naked slatey-blue skin which is raised somewhat from the body surface. The urogenital aperture is a transverse slit lying immediately posterior to the anus. Regan's specimen shows a similar appearance, although the eminence on which the vents open is only slight.

The stomach of the new specimen was completely empty.

THE FISHING LURE

Among the Pediculate fishes, the use of the cephalic tentacle as a fishing line in *Lophius* was first asserted by Aristotle. This has since been confirmed by the aquarium observations of Chadwick (1929) and Wilson (1937). Angling activity has also been observed in *Antennarius* (Mowbray, 1938 in Waterman, 1939*a*). In the more highly modified Ceratioid Pediculates the cephalic tentacle becomes a pro-

minent feature. This tentacle is derived from the modified front portion of the dorsal fin. Kröyer (1844) considered that in *Ceratias* it represented the first dorsal fin ray. Later authors (Brauer, 1908; Waterman, 1948) working on *Gigantactis*, have concluded that a rudiment of the second fin ray also enters into its structure.

In the Ceratiidae the cephalic tentacle achieves its most considerable development as an angling device. Here the first external ray of the fin, called the illicial ray or illicium, is suspended in front of the head upon an exsertion of the pterygiophor or 'basal bone' of that ray. The distal end of the illicium is expanded into a luminous bulb, so that this apparatus projecting from the head is virtually that of a fishing rod, line and bait. The cephalic tentacle of the new specimen is a stiff, slender rod which, when found, extended at an angle of 20° to the horizontal and protruded 15 cm. from its insertion on top of the head above the vestigial eyes. The illicial ray was jointed to its distal end and measured 6 cm. (Pl. I).

Waterman (1939*a*) has pointed out that it was Reinhardt (1837), describing *Himantolophus*, who first implied that the illicium functions as a lure. Later this was definitely asserted by Lutken (1871). The luminosity of the bulb, or 'esca', in certain Ceratioidea was first mentioned by Willemoes-Suhm (1877). In 1878 Gill independently suggested that the bulb was a luminous organ, and intimated its significance as a luminous bait for the lure. The bulb has been credited with other functions. Thomson (1877) described the illicium of *Ceratias uranoscopus* and favoured the belief (which may be partially true) that the terminal bulb is a sense organ, informing the angler fish of the approach of prey, rather than a lure to attract it. Goode (1880) and Goode & Bean (1895) expressed a similar opinion. A modification of this theory was advanced by Parr (1932), who suggested that the luminous organ subserved the sexual function of attracting the males (which have no functional illicium). This possibility has been further discussed by Waterman (1948).

Recently Bertelsen (1943) has been able to establish, beyond reasonable doubt, that the cephalic tentacle, at least in *C. holbölli*, is pre-eminently a fishing lure. He showed that the arrangement and musculature of the basal bone was such that it could either be exserted or withdrawn, and continues (p. 194): 'When the tentacle is withdrawn, the prey attracted by the luminous bait on the exserted tentacle may be lured straight into the mouth of the fish.' In connexion with this mechanism the dorsal tentacle is important. This structure occurs in all Ceratiidae and has been variously described as a tentacle, 'papilla' or 'pore' lying immediately in front of the caruncles on the dorsal surface. Kröyer (1844) considered it to be the second dorsal fin ray, and Regan & Trewavas (1932) described it as the third. Rauther (1941)* dissected a damaged specimen of *C. holbölli* and believed that the tentacle contained the prolongation of a pterygiophor which was jointed at its anterior end with the basal bone of the cephalic tentacle. But Bertelsen, working on an undamaged specimen, showed that the dorsal tentacle is in fact a sheath derived from the skin of the back, which receives the proximal part of the basal bone of the illicium. From its insertion on the head this long, slender fishing rod continues in a trough along the upper surface of the skull and between the dorsal muscles. When the rod is fully exserted the dorsal tentacle is invaginated and appears only as a pore raised on a short peduncle. When the rod is withdrawn its proximal end completely pierces the back and emerges, sheathed in pigmented skin, as this conspicuous dorsal tentacle. Bertelsen thus established the identity of the 'tentacle', 'papilla' and 'pore' of other authors, and in the light of this evidence proceeded to revise the systematics of the Ceratiidae.

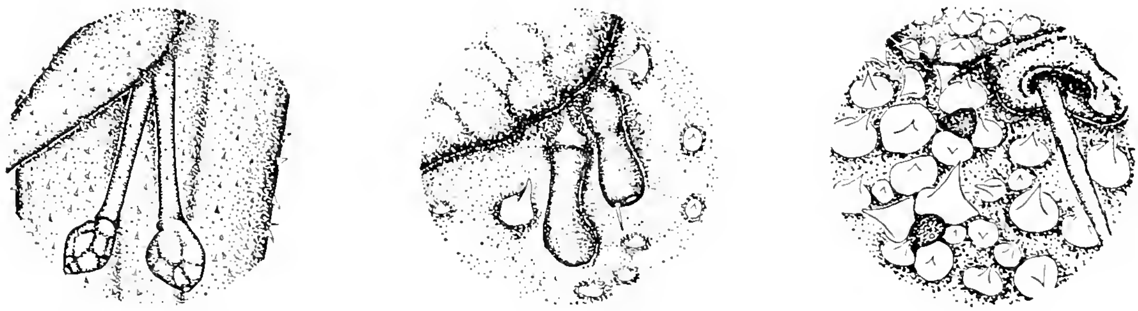
Bertelsen does not say that he was able to move the rod in and out, since the discovery of its extraordinary adjustability was deduced from morphological observations on fixed and hardened material. Now I had not read his 1943 paper when I first examined the new specimen, without dissection, on board the whaling factory ship 'Southern Harvester'. The following extract from my field notebook

* Quoted by Bertelsen (1943). Rauther's paper is not at present available in England (June 1949).

on 26 December 1947 is therefore advanced as independent evidence supporting Bertelsen's conclusions:

'When the fishing lure was removed for safe preservation I found it possible to withdraw the (basal) bone, without forcing, for a distance of 24 cm.... It extends back at least as far as the base of the dorsal tentacle, where it probably has its morphological origin (although an X-ray photograph* of this region was taken, but revealed nothing).... Is it possible that the rod can be pushed out and in, i.e. is adjustable for length? Certainly the rod, when half pulled from its insertion (on the head) and let go, slowly moved back again.'

The dorsal tentacle of the new specimen (Pl. I) is a cylindrical structure, quite soft and flaccid when fresh, and of a greyish black colour. The tip is slightly expanded. It measures 6 cm. and is raised upon a distinct peduncle 1·2 cm. high. According to Bertelsen's conclusions, this tentacle should have invaginated when the lure was pulled from its insertion. I cannot recollect this, but it may have happened and been overlooked, the examination being hurried and the phenomenon unsuspected. Alternatively, the proximal end of the rod may have become detached from the inside of the tentacle after death.



A B C

Fig. 2. *Ceratias holbölli* Kröyer. The caruncles. A, '*Mancalias tentaculatus*', × 5. B, Antarctic specimen, × 2½. C, Regan's specimen, × 1½.

In Regan's specimen the cephalic tentacle is absent and he notes 'that the dorsal tentacle is long, reaching beyond the base of the caudal fin, when laid back, and bears a terminal bulb' (Regan, 1926, p. 34). He considered this was either the normal structure of the dorsal ray, or an assumption of the structure and function of the cephalic tentacle caused by loss of this tentacle during life (Regan, 1925*a*). I have re-examined this long dorsal ray, which emerges from the torn base of the former integument of the tentacle (Fig. 2C). It is spirit material, and appears inelastic and much shrivelled. Probably it represents a part of the pterigiophor prolonged by remnants of its musculature; the 'terminal bulb' seems to be a bunched knob of connective tissues. There is little doubt that these damaged structures correspond to the dorsal tentacle of the Antarctic specimen.

The musculature of the cephalic tentacle of the Ceratioids has been studied in *Gigantactis* by Brauer (1908) and Waterman (1948), and in *Ceratias* by Rauther (1941) and Bertelsen (1943). Brauer could find only four pairs of muscles associated with the structure. Both Bertelsen and Waterman have recorded five pairs, which can be homologised in the two genera. Two of these muscles are the retractors and exsertors of the basal bone. They are elongate and weak in *Gigantactis* where fore-and-aft adjustability of the lure is not specially developed. On the other hand, in *Ceratias* they are elongate, but also large and powerful, and are the principal effectors of the mechanism already described. A third pair of muscles are attached to the basal bone. They are powerful in *Gigantactis*, where Waterman describes them as the inclinators of the illicium. They are small and weak in *Ceratias*, where they may also, as

* By the ship's surgeon, Dr Michael Gilkes, to whom I am indebted. Probably the hardness of the X-rays employed accounted for the failure.

Bertelsen points at, contribute to pull the tentacle forwards. The remaining two pairs of muscles are the erectors and flexors of the illicial ray at its joint with the distal end of the basal bone. In *Ceratias* these muscles are relatively small, but they are large and powerful in *Gigantactis*. Movement of the lure in *Gigantactis* is mostly at the level of the illicial ray, but in *Ceratias* at that of the basal bone.

The musculature of the lure in the new specimen has been examined. The precise attachments to the basal bone of the exsertors, retractors and inclinators could not be determined, since the lure had already been removed on preservation. But these three pairs of muscles appear virtually as described and figured by Bertelsen, to whose paper reference should be made. The black integument of the exserted part of the basal bone has been either torn or digested away, and the muscles of the illicial ray have suffered in this damage, so that only the flexors of this ray can be clearly distinguished at the joint with the basal bone. When the fish was found the illicial ray dangled vertically, making an acute angle with the inclined basal bone (Pl. I); damage to the illicial erectors would presumably account for this condition.

The black integument of the illicial ray of the new specimen is expanded distally into a pear-shaped esca (Fig. 4C). About the middle of this bulb the black pigment changes to a dull blue and then gives place to a distal unpigmented region, until the pigment is resumed again as a small disk at the extreme tip of the organ. Two short filaments, pigmented for about half their length, spring from this black disk which is also pierced by a round pore (Fig. 2A). The fixed material shows some jelly-like exudate in the pore; this may be the erstwhile luminous mucus which such an open type of luminous gland might be expected to release. This particular esca has not yet been examined histologically, but Dahlgren (1928) sectioned the esca of a specimen of *Ceratias* and described it as an open gland wherein light was produced by a culture of bacteria which filled most of its lumen.

A terminal pore appears also to be characteristic of the escas of species of *Mancalias* as figured by recent authors (Regan & Trewavas, 1932; Imai, 1941), and it is significant that Bertelsen now regards the genus *Mancalias* as synonymous with *Ceratias*. The arrangement of the pigment on the esca of the new specimen agrees closely with that given for the escas of Bertelsen's Greenland specimen and Kröyer's type (Bertelsen, 1943). The incidence, number and arrangement of filaments on the esca have been assigned some specific value by most systematists of the Ceratioidea. With regard to *C. holbölli* Regan's incomplete specimen does not assist in a comparison of the escal filaments, but Bertelsen, who has re-examined Kröyer's type, states that both his own Greenland specimen and the type agree in bearing only one terminal filament, whereas the Antarctic specimen has two (Fig. 4C and D. Fig. 4D is from Gaimard; the base of this esca appears to be torn). What validity this difference may or may not have as a taxonomic character will be discussed later.

THE CARUNCLES

On the back of the new specimen, close behind the dorsal tentacle, there are situated two club-shaped structures. They lie close about the middle line, the right a little forward of the left. These organs are the caruncles. They are black and glandular in appearance and 0·6 cm. high. Each bears a terminal pore. A sharp spine protrudes from the tip of the right caruncle, and a spine can be palpated in the other where its presence is betrayed as a slight bulge on one side (Fig. 2B). The presence of these spines supports Rauther's conclusions that the caruncles are modified fin rays (Rauther, 1941).

Kröyer, Rauther (1941) and Bertelsen all mention the presence of similar club-shaped caruncles in their specimens of *C. holbölli*. Regan (1925*a*, *b*, 1926) does not mention the caruncles in his specimen. It is clear, as Bertelsen has pointed out, that among the three genera of the Ceratiidae, Regan (1926) and Regan & Trewavas (1932) regard only *Cryptosparas* and *Mancalias* as possessing caruncles, and not *Ceratias*. However, careful examination of Regan's specimen reveals the presence of two black sessile bodies lying among the spines posterior to the peduncle of the damaged dorsal tentacle. They are

0·4 cm. high, and each bears a small pore. They are undoubtedly caruncles. Although more widely separated than those of the Antarctic specimen, the right caruncle still lies slightly in front of the left (Fig. 2C). The presence of caruncles may now be accepted as a character of all members of the Ceratiidae without exception. Their possible significance will be discussed later (p. 19).

THE VISCERA

Kröyer made brief reference to the internal organs of *Ceratias*. The viscera of Ceratioid dwarfed males have received attention from Regan (1925*a*) and from Parr (1930). The first complete account of the anatomy of a Ceratioid fish, however, is given by Waterman (1948) in his description of *Gigantactis longicirra*.

The following notes on the viscera of the new specimen are limited to what could be seen after a single median incision into the body cavity (Fig. 3).

The short wide oesophagus leads into a moderate stomach of somewhat caecal type. The cardiac stomach expands into equal pyloric and caecal portions, the latter being posterior. Externally the stomach appears compact, but its internal lining is strongly thrown into some twenty longitudinal folds. Doubtless this allows the stomach to accommodate large or numerous prey. Moreover, as Waterman has observed on *Gigantactis*, the coelom is large and has room for a distended stomach.

The duodenum leaves the stomach anteriorly and medianly, and passes right where it receives two pyloric caeca of somewhat unequal size. Kröyer mentions these two caeca in *Ceratias*, and it is interesting that Waterman found none in *Gigantactis*. At the junction of the pyloric caeca the duodenum expands to a wide, thin-walled tube which then receives the bile duct. The intestine passes back, suspended by its mesentery in overlapping loops, along the length of the stomach on the right-hand side until it narrows again, somewhat abruptly, level with the posterior end of the stomach. This narrower part, which presumably should properly be called the large intestine, is fairly long, and for the most part lies looped behind and above the stomach. It terminates in a short, straight, rectal portion. This gut differs from that of *Gigantactis* by its looped character and the inversion of the usual difference in size between small and large intestines. However, Waterman's specimen of *Gigantactis*, 3·9 cm. long, is doubtless an immature individual, and the relatively greater length of gut in *Ceratias* may probably be attributed to greater size and age rather than to a real morphological difference between the two genera.

The liver is of moderate size and bi-lobed. Waterman found an additional small third lobe in the liver of *Gigantactis*. The hepatic ducts of *Ceratias* unite to form a common duct which then divides into a large bile duct to the duodenum and a long and equally conspicuous cystic duct to the gall-bladder. This organ is large and lies dorsal to the stomach and posterior to the liver. *Ceratias* closely corresponds to *Gigantactis* in this arrangement.

The pancreas is a very finely diffuse, arborescent structure, lying in the mesentery between the hepatic portal vein and the gut. This agrees with Waterman's description of the pancreas in *Gigantactis*, except that in *Ceratias* it can be traced farther forward, beyond the hepatic portal, as far as the loop between the duodenum and the pyloric stomach. Posteriorly the pancreas of *Ceratias* is bounded by the posterior mesenteric and its associated intestinal vein.

The spleen is a subspherical body of median size, lying slightly forward of the bile duct in the mesentery between duodenum and liver. In *Gigantactis* Waterman found it below the posterior part of the intestine—a less typical position for the teleost spleen.

There is no swim-bladder. This confirms Kröyer's observation. Waterman, likewise, found no swim-bladder in *Gigantactis*, and the absence of this organ may well be characteristic of the Ceratioidea, as it is of many other groups of bathypelagic fishes (Rauther, 1937).

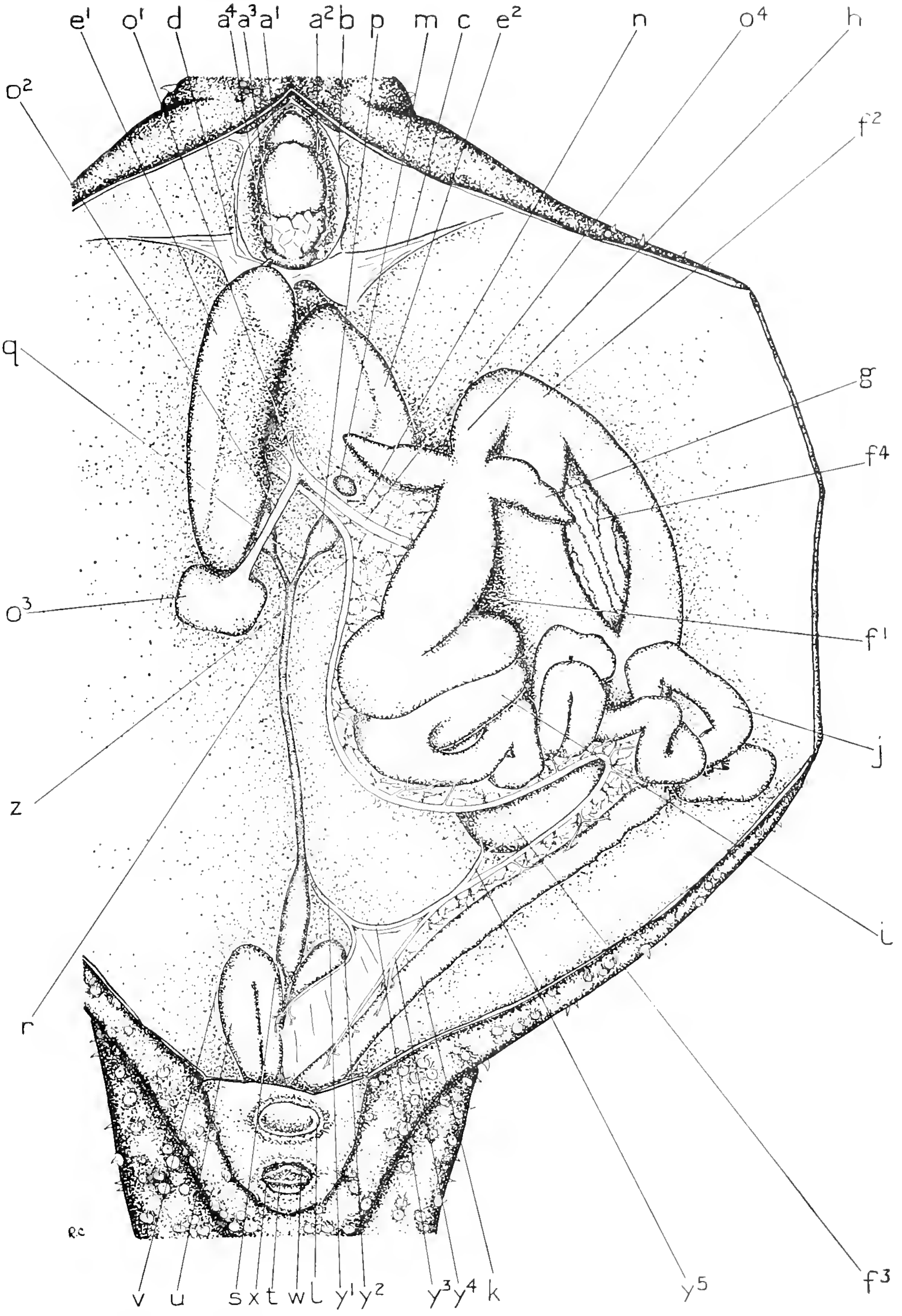
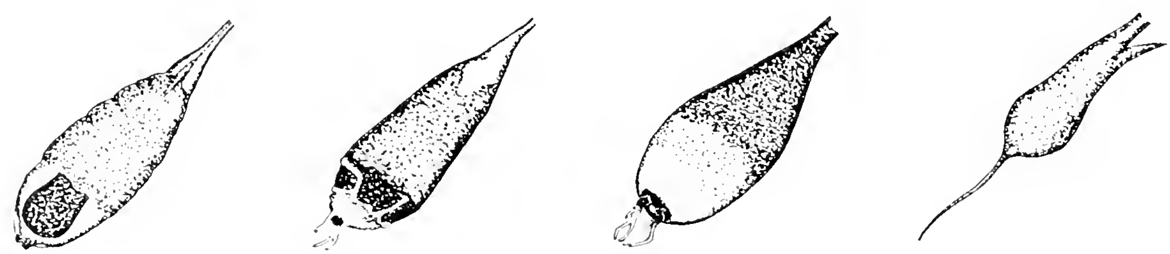


Fig. 3. *Ceratias holbölli* Kröyer. Viscera of the Antarctic specimen, $\times \frac{7}{10}$. a^1, bulbus arteriosus; a^2, ventricle; a^3, auricle; a^4, sinus venosus; *b*, pericardium; *c*, pericardio-peritoneal septum; *d*, hepatic vein; e^1 and e^2, right and left lobes of the liver; f^1, f^2 and f^3, cardiac, pyloric and caecal parts of the stomach; f^4, stomach opened to show longitudinal folding of the gastric mucosa; *g*, pyloric caeca; *h*, duodenum; *i*, small intestine; *j*, large intestine; *k*, rectum; *l*, anus; *m*, spleen; *n*, pancreas in the intestinal mesentery; o^1, hepatic duct; o^2, cystic duct; o^3, gall bladder; o^4, bile duct; *p*, left kidney; *q*, left ureter; *r*, renal duct; *s*, urinary bladder; *t*, urinary aperture; *u*, right ovary; *v*, integument of right ovary; *w*, left genital aperture; *x*, urinogenital cloaca; y^1, posterior mesenteric vein; y^2, ovarian vien; y^3, gastro-intestinal vein; y^4, intestinal vein; y^5, gastric vein; *z*, hepatic portal vein.

The heart lies well forward in front of a marked pericardio-peritoneal septum. It is enclosed in a strong pericardium and exhibits the typical teleost form. A conspicuous bulbus arteriosus is separated from the large ventricle by a constriction. The visceral blood supply is remarkable for the share taken by the venal portal system in draining blood from the gut. The posterior mesenteric vein, at a junction where it receives gastric and intestinal tributaries, is directly confluent with the posterior part of the hepatic portal. An ovarian vein joins the posterior mesenteric which then receives the caudal vein, in the region of the urinary bladder, and continues forward to the kidneys as the renal portal vein. In this part of its course it is closely applied to the median renal duct. Waterman has noticed that in *Gigantactis* also, and in a similar way, the renal and hepatic portal systems compete for the venous drainage of the gut.

As Waterman found in *Gigantactis*, the kidneys of the new specimen of *Ceratias* lie far forward. They are compact organs, partly embedded in the dorsal body wall above the oesophagus. Their ureters join to form a single renal duct which posteriorly dilates somewhat into a tubular bladder. This opens as a generous transverse slit in the shallow urinogenital cloaca.



A B C D

Fig. 4. *Ceratias holbölli* Kröyer. The esca, A, '*Mancalias bifilis*', × 18. B, '*Mancalias tentaculatus*', × $8\frac{1}{2}$. C, Antarctic specimen, × $2\frac{1}{4}$. D, Kröyer's type, × $1\frac{1}{6}$ (after Gaimard).

Waterman attributed to juvenility the smallness of the gonads in his specimen of *Gigantactis*. The size of the new specimen of *Ceratias* puts its sexual maturity beyond reasonable doubt (see p. 19), yet in this fish also the gonads are remarkably small. As all the ideas on the sexual dimorphism of these fishes would lead one to expect, these small gonads are indeed ovaries, and the sex of the specimen is confirmed. But microscopic examination of a teased fragment of the ovary revealed unripe, transparent eggs containing no yolk. Each consisted of a vitelline membrane enclosing a homogeneous cytoplasm which surrounded a large, central nucleus. The largest ova had diameters up to 16μ. The presence of small regressed ovaries, containing eggs in such a young stage of development, suggests a resting condition in an animal characterized by a well-defined and probably short breeding season. If this were general among the Ceratioidea, then it may be supposed that the solitary, sluggish and probably sparsely distributed females might well achieve and pass their sexual season before any free-living males happened to find them. Is it not therefore possible that a severely restricted breeding season may have been a major stimulus leading to the evolution of dwarfed males which become permanently attached to the females? If so, then the suggestion (Regan, 1925*a*; Parr, 1930, 1932) that the milting of the male may be under direct hormonal control from the female acquires added significance.

The ovaries exhibit the cystoarian condition, and are otherwise interesting in that each is strongly bent upon itself into a U-shape within its integument. Each opens separately to the exterior, and the paired genital openings are located within the shallow urinogenital cloaca immediately anterior to the transverse slit of the urinary aperture.

Regan's specimen had been gutted and no observations can be made upon its viscera.

It may be concluded that the visceral organs of *Gigantactis* and *Ceratias* are, in general, similar, differing principally in the presence of two pyloric caeca in *Ceratias*. Kröyer's remarks on the viscera of *Ceratias* are confirmed.

No internal or external parasites were observed in the Antarctic specimen.

THE GROWTH OF *CERATIAS HOLBÖLLI*

Apart from the single discrepancy in the number of escal filaments, the foregoing description and comparison establishes with fair certainty that the Antarctic specimen is, in fact, an adult of *C. holbölli* Kröyer.

Additional evidence is provided by an examination of the bodily proportions of this and other specimens in the genera *Ceratias* and *Mancalias*. Parr (1932), identifying two Ceratiids as *Mancalias uranoscopus* Murray, paid some attention to their proportions and attributed certain discrepancies to disparity of age. Later Bertelsen (1943) compared the proportions of eight specimens of Ceratiids, including species of *Ceratias* and *Mancalias*. Where there were disagreements in these measurements (expressed as percentages of the standard length) he followed Parr in emphasizing that they could be due to differences in size of the specimens. He concluded, therefore, that *Mancalias* and *Ceratias* could not be distinguished by measurement, so that there was nothing here to contradict his demonstration (based mainly on the mechanism of the cephalic tentacle) of the invalidity of the genus *Mancalias*.

The discrepancies that Parr and Bertelsen noticed are immediately explicable if there is any allometry of the proportions concerned. The investigation of allometry as a method in taxonomics has been stressed by Huxley (1932) and subsequently discussed by Worthington (1940) and de Beer (1940).

Accordingly, by substitution in the simple allometry formula* $y=bx^{\alpha}$, I have tested the measurements of the eight specimens tabulated by Bertelsen, and five additional specimens which are of significance in the systematics of the Ceratiidae.

Table 1 shows the measurements of thirteen specimens of the genera *Mancalias*, *Miopsaras*† and *Ceratias*. Besides the eight individuals previously tabulated by Bertelsen, the table includes Regan's specimen, the new Antarctic specimen and the type of *Mancalias sessilis* Imai, together with representatives of the two southern species; viz. the type of *M. tentaculatus* Norman and the smaller of the two existing specimens of *M. bifilis* Regan & Trewavas. I have been able to examine these last two specimens in the Natural History Museum Collection. The measurements record the size of 21 dimensions or parts in each specimen, but there are a few omissions. Dimensions are given as percentages of the standard length, and from these the actual measurements have been recalculated‡.

The values for each dimension have been plotted against standard length on a double logarithmic scale. The resulting graphs are shown in Fig. 5 (*a–u*). It will be seen that except for graphs *b* and *d*, the points for the graphs of each dimension give good agreement to a single straight line. In the last two graphs (*t* and *u*), viz. those for diameter of eye and length of nostril, there are admittedly only four points available, but the arrangement of these points strongly suggests a straight-line relationship, and their inclusion is justified by inference from the conformity of the remaining seventeen graphs. The appearances of graphs *b* and *d* are explicable and will be considered below. Apart from these, therefore, it is seen that, in the specimens under examination, all the recorded dimensions have values showing the straight-line relationship required by

$$\log y = \log b + \alpha \log x.$$

* For terminology see Huxley & Teissier (1936) and Reeve & Huxley (1945).

† Regan & Trewavas (1932) included *Miopsaras* Gilbert 1903 with *Mancalias*.

‡ Except for nos. 1, 2, 9 and 12, where absolute measurements were directly available.

Table 1. Mancalias, Miopsaras *and* Ceratias *Spp. Dimensions (after Bertelsen, 1943 with additions)*

Dimension	1 *Mancalias bifilis* (Regan & Trewavas, 1932)	2 *Mancalias sessilis* (type Imai, 1941)	3 *Mancalias uranoscopus* (Parr, 1932)	4 *Ceratias uranoscopus* (type Murray, 1877)	5 *Mancalias tentaculatus* (type Norman, 1930)	6 *Miopsaras myops* (type Gilbert, 1903)	7 *Ceratias* n.sp. (Murray & Hjort, 1912)	8 *Ceratias holbölli* (Bertelsen, 1943)	9 New specimen from the Antarctic	10 *Mancalias uranoscopus* (Parr, 1932)	11 *Ceratias holbölli* (Saemundsson, 1939)	12 *Ceratias holbölli* (Regan, 1925)	13 *Ceratias holbölli* (type Kröyer, 1844)
Total length (cm.)	2·00	3·60	5·2	7·6	11·0	11·4	13	..	..	62	c. 100	97	119
Standard length (cm.)	1·60	2·80	3·8	6·0	7·8	8·1	9·8	18·5	43	48	65	67	68
% of standard length:													
(*a*) Length of illicium	34	28	..	23	27	..	27	24	16·2	..	14	..	c. 17
(*b*) Length of exserted part of basal bone	63	18	..	72	31	..	11	17	35	..	..	..	c. 83
(*c*) Total length of basal bone	97	..	..	..	101	..	70	93	79	..	80	..	..
(*d*) Height of caruncle, stalk included	4·4	4·6	5·5	6	7·7	5		2·7	1·4	1·04	0·7	0·6	c. 1
(*e*) Snout to base of tentacle	22	..	..	21	19·2	..	22	23	15·8	..	19·7	18·7	13·2
(*f*) Snout to dorsal fin	78	68	78	71	74	68	70	69	72	c. 76	71	70	c. 74
(*g*) Snout to anal fin	81	68	..	76	76	74	75	75	77	..	78	77	..
(*h*) Snout to base of pectoral fin	47	39	37	43	39	39	45	40	32	36	42	33	37
(*i*) Length of maxillary	18·8	..	19	21	19·9	21	..	17·3	14·4	13·4	14·2	13·1	12·2
(*j*) Length of lower jaw	22	..	24	..	23	22	20	18·2	17·9	15·6	17·9	16	17
(*k*) Greatest depth of body	38	43*	33	45	35	36	38	38	49	36	49	42	46·2
(*l*) Depth of caudal peduncle	12·5	12	8·5	11	9	9	9	8·1	9·3	5·3	10·8	9·4	7·8
(*m*) Base of tentacle on head to base of tentacle (papilla, pore) on back	44	..	..	..	44	40	33	36	43	..	38·5	40	32·6
(*n*) Dorsal fin to caudal fin	12·5	17*	13	16	16·6	16	16	17·3	13·9	13·4	13·3	13·4	16·6
(*o*) Anal fin to caudal fin	11·3	19*	13	15	16·6	16	17	16·8	13·9	9·2	12·5	13	11·5
(*p*) Base of tentacle (papilla, pore) on back to dorsal fin	22	..	14	..	12·8	13	12	12·4	14·9	18	13·7	14·8	13·8
(*q*) Posterior caruncle to dorsal fin	15·6	..	10	13	9·6	10	9·5	8·1	13·2	14	9·9	12·2	..
(*r*) Base of dorsal fin	9·4	11	9	9	9·0	12	13	10	10·7	10·4	10·2	15·4	9·6
(*s*) Base of anal fin	6·3	11	8·5	8	7·7	12	11	8·4	8·1	7·7	9·7	9·3	8·1
(*t*) Diameter of eye	2·5	..	..	..	1·36	..	..	..	0·81	..	..	0·6	..
(*u*) Length of nostril	2·5	..	..	..	2·27	..	..	..	2·09	..	..	1·19	..

The measurements of Nos. 4, 6 and 7 are approximate, based only on drawings of these specimens' (Bertelsen, 1943, p. 198).

* These three measurements are also approximate, being from Imai's figure (1941, p. 245).

I believe that this is good evidence that all the thirteen specimens considered belong to a single species, and that the differences between measurements for any particular dimension may be attributed to simple allometry.

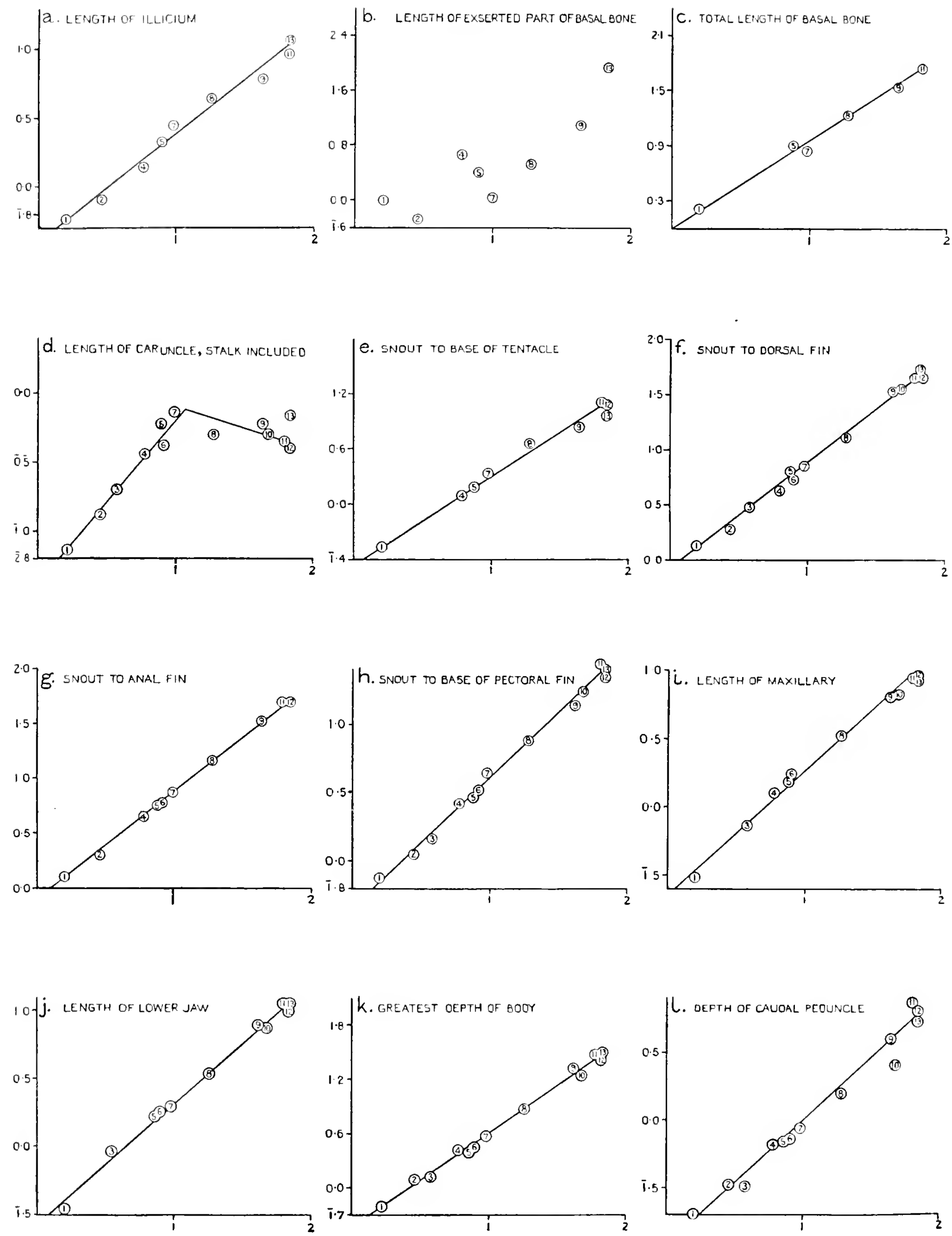
These graphs, therefore, provide a fairly complete picture of relative growth in *Ceratias holbölli* Kröyer from 1·60 to 68 cm. standard length, i.e. from juvenile to adult size. Accordingly, for each dimension the growth constant (α) has been measured (= tangent of the angle of slope of the straight line). Table 2 shows these growth constants.

It will be seen that in twelve of the dimensions (*c*, *e*, *f*, *g*, *h*, *k*, *m*, *n*, *o*, *q*, *r*, *s*) growth is isometric, i.e. $\alpha = 1 \pm 0{\cdot}05$. This group includes the dimensions relating to the positions of the dorsal and anal fins which Parr found to show small differences in his two specimens of *Mancalias uranoscopus* (Table 1, nos. 3 and 10). In the run of specimens now being examined the small differences are found not to be significant.

Regarding the same two specimens Parr also found that the following dimensions were relatively smaller in his larger specimen (no. 10): length of maxillary, length of lower jaw and depth of caudal peduncle. This is substantiated in Table 2, where these three dimensions (*i*, *j* and *l*) all show slight negative allometry ($\alpha = 0{\cdot}90 - 0{\cdot}92$). The distance of the base of the tentacle (papilla, pore) on the back, to the dorsal fin (*p*), is likewise slightly negatively allometric ($\alpha = 0{\cdot}92$). Parr's observation was the converse of this, a discrepancy due, as he suspected, to the damaged condition of his larger specimen.

The length of the illicium (*a*) shows marked negative allometry ($\alpha = 0{\cdot}78$). Bertelsen also drew attention to the decrease in length of the illicium and the jaws with increasing length of the individuals. Since the total length of the basal bone (*c*) remains isometric, it is likely that the pronounced decrease in the relative length of the illicium during ontogeny is associated with the negative allometry of the jaws (*i* and *j*), and perhaps with an increase in the distance that the basal bone can be retracted. The relative growth of the illicium would then be such as to keep the esca in line with a bisection of the angle of gape when the lure is retracted.

It will be seen that in *Ceratias holbölli* there is considerable reduction in two of the sense organs during growth to adult size. Data on the diameter of the eye (*t*) and the length of the nostril (*u*) are confined to the four specimens (nos. 1, 5, 9 and 12) which I have myself been able to examine. The points plotted on the log log scale are grouped sufficiently close to a straight line to advance values for the growth constants of about 0·6 for the diameter of the eye and 0·8 for the length of the nostril. It is significant that in *C. holbölli* the eye should show the greatest degree of allometry among the organs or dimensions investigated. It may be recalled that both the Antarctic specimen and Regan's specimen (nos. 9 and 12) are functionally blind. Now, in the two other specimens I have examined, viz. the second specimen of *Mancalias bifilis* Regan & Trewavas and the type of *Mancalias tentaculatus* Norman (nos. 1 and 5) which may now be regarded as juvenile *Ceratias holbölli*, the eyes, although reduced, are exposed and doubtless functional (Fig. 1*b*). It is clear therefore that the eyes, besides suffering reduction during ontogeny become also subcutaneous and acquire the condition of the eyes of the adult forms (nos. 9 and 12). A transparent disk, surrounded by a pigmented ring, has been mentioned lying just ventral to the concealed eye in the Antarctic specimen. This structure represents the conjunctiva of the eye in the juvenile fish, and the subcutaneous condition would have been achieved by the establishment of an active growth centre, at some stage in ontogeny, in the skin immediately above the eye. Such locally accelerated skin growth would then carry the conjunctiva and its pigmented border bodily across the eye and so conceal it. Even in the stage represented by '*Mancalias bifilis*' (no. 1) the shape of the aperture of the eye suggests that the occluding process may already have begun (Fig. 1 B). The final condition would be that found in the Antarctic specimen (Fig. 1 A). The fact that Gaimard's figure of the type specimen shows visible eyes does not by itself invalidate the argument. Their portrayal may be accountable to the artist, or to some damage of the material which revealed the eyes.


a. LENGTH OF ILLICIUM
b. LENGTH OF EXSERTED PART OF BASAL BONE
c. TOTAL LENGTH OF BASAL BONE
d. LENGTH OF CARUNCLE, STALK INCLUDED
e. SNOUT TO BASE OF TENTACLE
f. SNOUT TO DORSAL FIN
g. SNOUT TO ANAL FIN
h. SNOUT TO BASE OF PECTORAL FIN
i. LENGTH OF MAXILLARY
j. LENGTH OF LOWER JAW
k. GREATEST DEPTH OF BODY
l. DEPTH OF CAUDAL PEDUNCLE

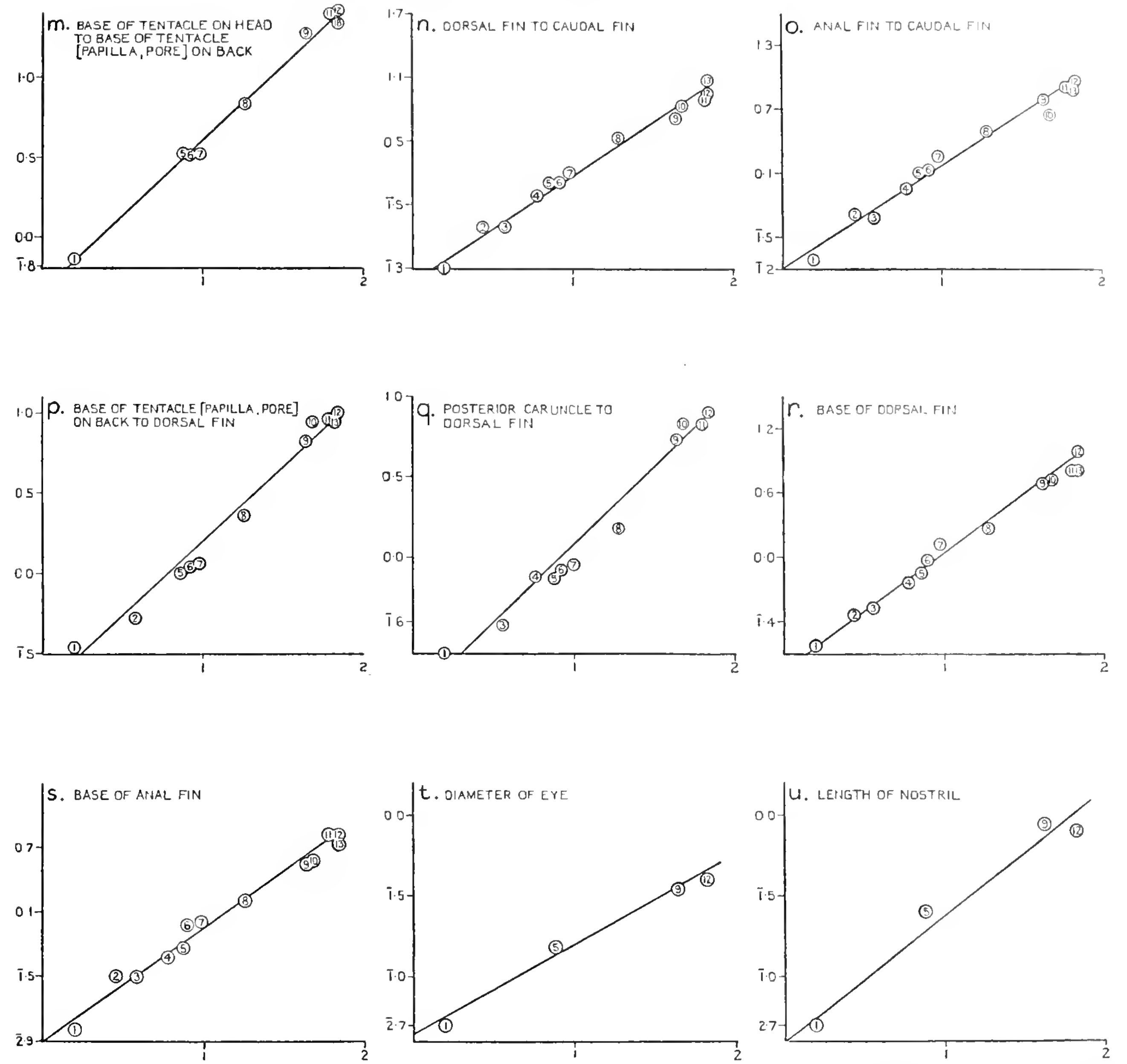


Fig. 5. (*a* to *u*). *Ceratias holbölli* Kröyer. Allometric growth. Dimensions of *Ceratias* and *Mancalias* spp. plotted against standard length on a double logarithmic scale. (The numbers refer to individual specimens recorded in Table 1.)

Ceratias holbölli is thus a blind fish in which the functional eyes of the young become reduced and then covered by opaque skin in the adult. There are certain other fishes which resemble *C. holbölli* in possessing eyes that are reduced and subcutaneous when adult, but functional in the juvenile stages. These are the Brotulids *Lucifuga* and *Stygicola*, and the goby *Typhlogobius* (Norman, 1931)

The degree of negative allometry of the nostrils in *Ceratias holbölli*, although not so great as that of the eyes, is nevertheless pronounced. In the juveniles '*Mancalias tentaculatus*' and '*M. bifilis*', these organs are fairly conspicuous, and it is curious that they appear to have previously been overlooked. They are hollow tubercles projecting on each side of the head, half-way between the eyes and the edge of the premaxilla (Fig. 1 B). In the adult *Ceratias holbölli*, as represented by Regan's and the Antarctic specimen, they become reduced, flattened and tag-like (Fig. 1 A). Although they still retain their lumen, it is probable that in this adult condition they are little or no better than useless vestiges. Even

in the juvenile fish it is doubtful whether they are functionally efficient since Waterman found that in his specimen of the Ceratioid *Gigantactis longicirra*, which was probably a juvenile, the structure of the slender tubular nostrils and their innervation suggested to him that olfaction was unimportant.

Table 2. Ceratias holbölli *Kröyer*. *Growth constants* (α) *of the dimensions*

Part	Value of the growth constant (α) in $y = bx^{\alpha}$
(*a*) Length of illicium	0·78
(*b*) Length of exserted part of basal bone	—
(*c*) Total length of basal bone	0·97
(*d*) Length of caruncle, stalk included. Specimens 1–7	1·20
Length of caruncle, stalk included. Specimens 8–12	−0·34
(*e*) Snout to base of tentacle	0·98
(*f*) Snout to dorsal fin	0·99
(*g*) Snout to anal fin	1·00
(*h*) Snout to base of pectoral fin	0·98
(*i*) Length of maxillary	0·90
(*j*) Length of lower jaw	0·91
(*k*) Greatest depth of body	1·05
(*l*) Depth of caudal peduncle	0·92
(*m*) Base of tentacle on head to base of tentacle (papilla, pore) on back	0·96
(*n*) Dorsal fin to caudal fin	1·01
(*o*) Anal fin to caudal fin	0·98
(*p*) Base of tentacle (papilla, pore) on back to dorsal fin	0·92
(*q*) Posterior caruncle to dorsal fin	1·00
(*r*) Base of dorsal fin	1·04
(*s*) Base of anal fin	1·04
(*t*) Diameter of eye	0·6
(*u*) Length of nostril	0·8

It remains to consider the exceptional dimensions *b* and *d*. There is obviously no lineal or other relationship between the scattered points obtained on the log log graph of dimension *b*, the length of the exserted part of the basal bone. In view of the adjustability of the lure, this scattering is precisely what one would expect. Any appearance other than a random scattering would have seriously damaged Bertelsen's arguments for invalidating the genus *Mancalias*.

Both Parr and Bertelsen have stated that the relative size of the caruncles decreases strongly with increase in length of the individuals. Actually the growth of these curious organs is somewhat more complicated, and the comments of these authors require modification. The log log graph of caruncle length (*d*) shows that growth of this organ in *small* individuals (nos. 1–7) is not negatively allometric as Parr & Bertelsen implied. Rather there is marked positive allometry ($\alpha = 1{\cdot}20$) at this stage, and it is noteworthy that the young caruncle is the only organ or dimension in the growth of *Ceratias holbölli* which shows significant positive allometry.

A slight error in the measurement of a comparatively small dimension like caruncle length becomes magnified when plotted on a logarithmic scale of this kind. Remembering this it is seen that five of the six remaining points can be represented by a second straight line. The last point (no. 13) refers to the caruncles of Kröyer's type and is an approximation calculated from the somewhat vaguely delimited caruncle in the figure of the type in Gaimard (1842–56, Poissons, pl. ix). Under these circumstances it would appear reasonable to ignore it. The caruncles of all the specimens are now accounted for.

At the point of intersection of the two lines, the growth constant changes abruptly to $\alpha = -0{\cdot}34$. This change in sign of the growth constant means that at a period corresponding to an individual of 12 cm. and of caruncle size 0·75 cm. (Fig. 5D) the growth of the caruncle changes abruptly from positive

allometry to *enantiometric* (i.e. absolute negative) growth. From this point onwards during ontogeny the *absolute* size of the caruncles decreases.

True negative growth of this kind has been observed, for instance, in the abdominal limbs of crabs at, and shortly after, metamorphosis (Huxley & Teissier, 1936). The association in this instance with metamorphosis, and its abrupt and unique occurrence in the growth pattern of *C. holbölli*, suggests that the onset of enantiometry betrays a crisis in the development of the organism. In *C. holbölli* this crisis is most likely to be sexual maturity which would then be attained when the fish reaches 12 cm. standard length. Bertelsen (1943, p. 202, fig. 5) divides adult specimens of *C. holbölli* from juveniles at the presumably arbitrary figure of 15 cm. *total* length, and it is interesting that this value should virtually correspond with the one obtained from the log log curve.

If enantiometry of the caruncles does indeed coincide with sexual maturity, then these organs probably have some kind of sexual significance. Rauther (1941) has shown that the caruncles are luminous. In the darkness of the deep sea it is to be supposed that the female *C. holbölli* possesses some luminous device to which the free-swimming males of the species may be instinctively attracted. Parr (1932) suggested that the illicial esca might attract in this way. Now Waterman (1948), considering the Ceratioidea generally, has further discussed Parr's suggestion, and has pointed out that, since the structure of the esca differs considerably between, and even within, many genera of Ceratioids, the free-swimming males may thus have been enabled to discriminate between females of different genera or species. The objection to this view in *C. holbölli* is, of course, that the male is likely to be swallowed as prey by the blind female, unless the latter possesses chemoreceptors capable of detecting the proximity of a male. In the seeing Ceratioid *Gigantactis* this arrangement is possible, since Brauer (1908) has found sensory endings in the esca which are apparently gustatory; moreover, Waterman has stressed the considerable sensory innervation of the esca in this form. But these sensory nerves are most likely associated with the bunch of filaments characterizing the esca of *Gigantactis*, whereas in *Ceratias holbölli* the filaments are reduced to a vestige. Also *Gigantactis* lacks caruncles which are a feature peculiar to the Ceratiidae. It is probable, therefore, that here the caruncles, and not the esca, function as the luminous recognition mark for the male. Beebe & Crane (1947) observed a moribund specimen of '*Mancalias uranoscopus*' immediately after capture, and noted that the caruncles moved slowly back and forth alternately. So it may be that luminosity of the caruncles is combined with a characteristic signalling movement.

Since the caruncles may be supposed to reach their absolute maximum size and presumably maximum luminosity at sexual maturity, it follows that the males would have the best chance of finding the females round about that time. A male is therefore likely to become attached early in the female's sexual life, but her chance of securing a male after sexual maturity would become progressively smaller as she grows larger. In this respect it is interesting that, among the fourteen individuals over 12 cm. standard length, and therefore supposedly adult (Table 3), only three had dwarfed males attached to them.

The change in shape of the caruncle during ontogeny is shown in Fig. 2A, B and C. In the juvenile there is a marked differentiation into a head and a stalked region. At a later period, presumably after the onset of enantiometry, the club shape becomes progressively less pronounced, until the aged individual may bear completely sessile caruncles which are reduced to mere black prominences among the spines of the back. Fig. 2 also shows how the caruncles become gradually separated as growth proceeds, although the right caruncle always remains slightly anterior to the left. Terminal pores are apparently characteristic of the caruncles at all stages, since they were present in all the four specimens I examined (nos. 1, 5, 9 and 12). They suggest an open type of luminous gland, resembling that of the esca.

It would be interesting to undertake the histological examination of caruncles derived from a series of juvenile and adult *Ceratias*. This should reveal changes of structure, and possibly function, which could be compared with the present inferences based on measurement only.

THE SYSTEMATICS OF *CERATIAS*

When Bertelsen had demonstrated, by his work on the fishing lure, the invalidity of the genus *Mancalias* Gill, and so reduced the Ceratiidae to the genera *Cryptosparas* and *Ceratias*, he reviewed the species of the latter genus in a synopsis* reproduced below:

Ceratias Kröyer 1844

Illicium with long slender stem. Two caruncles.

1. Bulb of illicium in adult specimens with one filament	holbölli
(*a*) Dorsal fin concealed under skin, stalked caruncles	sub sp. xenistius
(*b*) Dorsal fin of normal structure, sessile caruncles	sub sp. sessilis
(*c*) Dorsal fin of normal structure, stalked caruncles	sub sp. holbölli
2. Bulb of illicium with a pair of filaments	tentaculatus

This synopsis may now be re-examined and further simplified.

Apart from *xenistius*, all the forms here set down have been investigated, either as types or representatives, in the previous section on the growth of *C. holbölli*. Of 21 dimensions investigated for allometry in each, the results, without exception, are consistent with the conclusion that these forms are all either juveniles or adults of a single species. It is relevant here to notice an observation of de Beer (1940, p. 380), who, referring to species with allometric organs, stated: 'whilst there is in such cases inconstancy of *form*, there is constancy of *form-change* and this, measured by the value of the growth constant α, is also a specific character.'

Assessing the members of Bertelsen's synopsis in order, it appears that the first, *C. holbölli xenistius*, should remain as a subspecies for the time being. Regan & Trewavas (1932) described this form as *Mancalias xenistius* from a single specimen. The dorsal fin was most unusual, being virtually concealed and only appearing externally as (p. 99), 'a series of four pores which are the openings of black glands'. Possibly this is a teratological specimen.

The subspecies *sessilis* was described by Imai (1941) as *Mancalias sessilis* and distinguished by the absence of a stalk to the caruncles. Imai gives a list of measurements, and this form appears in Table 3 and Fig. 5 as no. 2. There are no discrepancies. With regard to the caruncles, it is seen (Fig. 5D) that their length fits the simple allometry equation for sexually immature individuals. They are pear-shaped in appearance because their stalks are less constricted than those of the club-shaped caruncles of other specimens. This is doubtless a minor individual variation and cannot be assigned subspecific rank.

Bertelsen's reference to 'stalked' or 'sessile' caruncles in his synopsis appears to be due to a confusion of Imai's meaning. It has been shown in the previous section that, because of enantiometry in adult life, the caruncles may become truly sessile in the ageing individual (e.g. Regan's specimen of *Ceratias holbölli*). Previous to this late ontogenetic change, the caruncles of all members of the genus are characteristically more or less pedunculate, and reference to 'stalked' as distinct from 'sessile' caruncles is misleading in a taxonomic context. The revised species *C. holbölli* now consists of the two subspecies *xenistius* and *holbölli* only.

Bertelsen's second species *C. tentaculatus* includes *Mancalias tentaculatus* Norman, 1930 and *Mancalias bifilis* Regan & Trewavas, 1932. These two species had been distinguished from each other

* As published, Bertelsen's synopsis contained typographical errors which have been corrected by reference to his text.

by the difference in length of their dorsal tentacles, and Bertelsen, by his work on the adjustability of the lure, has shown that this is not a real distinction. However, he has separated them from *Ceratias holbölli* because they comprise the only specimens of *Ceratias* hitherto caught in southern waters beyond the tropics, and because they have two filaments on the illicial esca.

There are, at present, three individuals of Bertelsen's *C. tentaculatus*. They are the holotype of *Mancalias tentaculatus* (standard length 7·8 cm.), the type of *M. bifilis* (7.5 cm.), and the small fish 1·6 cm. which Regan & Trewavas (1932, p. 100) have stated 'may belong to this species'. Of these the first and third are preserved in the Collections of the British Museum (Natural History), where I have been able to examine them. In Table 3 and Fig. 5 they are included as nos. 5 and 1 respectively. The type of *M. bifilis* had been returned to Copenhagen and was not available to me. According to Bertelsen's classification, the new Antarctic specimen (no. 9) would be regarded as the adult of *C. tentaculatus*, the other individuals being juveniles.

In discussing the validity of this species, it may be said, at once, that in the two small individuals (nos. 1 and 5) there are no differences from *C. holbölli*, excepting perhaps the number of filaments on the esca, which cannot be attributed to juvenility. The fate of their exposed eyes and tubular nostrils, undergoing marked negative allometry, has already been noticed, together with the conformity of their other bodily proportions to the simple allometry equation. Of other features, the pectoral fin in each specimen has seventeen rays. Kröyer's type of *C. holbölli* and the Antarctic specimen had nineteen rays in the pectoral fin, Regan's specimen eighteen and Bertelsen's two specimens had seventeen each. As in the adult fishes, the number of teeth varies, being $\frac{7}{30} \cdot \frac{7}{30}$ in the specimen of *Mancalias bifilis* and *c.* $\frac{13}{15} \cdot \frac{13}{15}$ in *M. tentaculatus*, and this is not considered significant. The lateral line organs on the head of the Antarctic specimen are found also in *M. tentaculatus*, where they are more extensive, continuing above the eye and then down the body as far as the caudal peduncle. They were not observed in the much smaller specimen of *M. bifilis*.

Bertelsen's first reason for recognizing *Ceratias tentaculatus* as a new species is that the three individuals comprising its synonyms, *Mancalias tentaculatus* and *M. bifilis*, are the only three specimens of *Ceratias* hitherto taken in waters south of the tropics. So few specimens of *Ceratias* are known that this implication of a discontinuous distribution is neither supported nor disproved by his chart (Bertelsen, 1943, p. 202), which, equally well, suggests that specimens of the genus may be distributed without interruption through the oceans.

The morphological feature of an esca bearing two filaments, supposed by Bertelsen to be a second character distinguishing the southern form, is certainly present in the new adult specimen from the Antarctic (Fig. 4C), and in the types of *Mancalias tentaculatus* (Fig. 4B) and *M. bifilis*. But in the remaining (fourth) southern specimen, viz. the smaller specimen of *M. bifilis* (no. 1), there is only a slight rudiment to represent the filament or filaments (Fig. 4A). The esca of this specimen resembles that of the juveniles '*M. sessilis*' and '*M. uranoscopus*'. Bertelsen, who attributed the naked esca of *M. uranoscopus* to juvenility, requires that in his classification the northern form should possess only one escal filament in the adult. But of the thirteen known adults of *Ceratius holbölli* from northern waters, the escas of only two are definitely known to bear one filament, viz. Kröyer's type and Bertelsen's Greenland specimen (Bertelsen, 1943). In all the other northern adults the cephalic tentacle has either been damaged, lost or not described.

It is not, therefore, considered that the descriptions and material at present available are sufficient to justify any splitting of the single species apart from the tentative isolation of the anomalous *xenistius* as a subspecies. It may be, indeed, that Bertelsen is correct and that the escal filaments are a sub-

specific character absent in the small forms but appearing in later juveniles and adults, and distinguishing a northern form with one filament from a southern form with two. Only the collection of further specimens can decide this point. It is, in any case, doubtful whether even a grouping of subspecific rank has any validity when erected on the distinction of such a single, slight and isolated feature, and in the face of so many characters which conform.

In the synopsis below the genus is reduced to a single species

Ceratias Kröyer, 1844

Illicium borne on long slender pterygiophor. Adult esca with one or two filaments only. Two caruncles holbölli

(*a*) Dorsal fin of normal structure subsp. holbölli

(*b*) Dorsal fin concealed under skin subsp. xenistius

Bertelsen's synonymy is revised and extended as follows:

Ceratias holbölli holbölli

Ceratias holbölli Kröyer, 1844, p. 639, and in Gaimard, 1842–56, Poissons, pl. ix, *et auctorum.*
Ceratias uranoscopus Murray in Thomson, 1877, p. 70, fig. 20; Günther, 1887, p. 54, pl. xi, fig. *c.*
Ceratias shufeldti Günther, 1887, p. 54.
Mancalias uranoscopus Gill, 1878, p. 227; Goode, 1880, p. 469; Jordan & Gilbert, 1882, p. 848; Goode & Bean, 1895, p. 490; Regan, 1926, p. 37; Regan & Trewavas, 1932, p. 99; Parr, 1932, p. 13; Norman, 1939, p. 116; Beebe & Crane, 1947, p. 169.
Mancalias uranoscopus triflos Roule & Angel, 1933, p. 57, pl. iii, fig. 27.
Mancalias shufeldti Goode & Bean, 1895, p. 490, fig. 401.
Typlopsaras shufeldti Gill, 1883, p. 284; Jordan, 1885, p. 138.
Miopsaras myops Gilbert, 1903, p. 694, pl. xlix.
Mancalias sessilis Imai, 1941, p. 233, fig. 12.
Mancalias tentaculatus Norman, 1930, p. 355, fig. 45; Regan & Trewavas, 1932, p. 100.
Mancalias bifilis Regan & Trewavas, 1932, p. 100, pl. vi, fig. 1.
Ceratias tentaculatus Bertelsen, 1943, p. 203.

Ceratias holbölli xenistius

Mancalias xenistius Regan & Trewavas, 1932, p. 99, pl. vi, fig. 2.

THE DISTRIBUTION OF *CERATIAS HOLBÖLLI*

Bertelsen has pointed out that the oceanic expeditions have never taken large adult specimens of *C. holbölli*. All these have come from the coastal waters of Iceland, Greenland and Nova Scotia. Consequently, until Bertelsen identified the juveniles of *C. holbölli* and showed them to be more widely distributed, the species was generally supposed to be a northern form which, unlike most Ceratioids, was not markedly of bathypelagic and oceanic habit. Bertelsen found this view no longer tenable and, regarding the absence of adults from oceanic collections, concluded 'the reason is, no doubt, that the gear hitherto used for bathypelagic fishing has not been able to capture these larger individuals'.

The new specimen of *C. holbölli* was removed from a Sperm whale shot in mid-ocean in a high southern latitude. It is thus the first adult specimen from oceanic waters, and its manner of capture substantiates the correctness of Bertelsen's observation. It is some years since Hjort (1912, p. 36) remarked '...the whale is still far more capable of catching living marine creatures than any scientific appliance hitherto invented'. This is no less true to-day, although possible methods of the future have been discussed by Kemp *et al.* (1939). Meanwhile it is well again to stress that routine exminations of the stomach contents of Sperm whales can do much to increase our scanty knowledge of the nektonic

macrofauna. The results may suggest that some bathypelagic Squids and fishes are more common and achieve greater sizes than is at present supposed.

When the new specimen was found, the floating factory was in position 61° 20′ S, 102° 50′ E, and the sperm whale must have been shot within, at most, 100 miles radius of this position because the whale-catchers never steamed farther than this distance from the factory during the season. The area (200 miles in diameter) is not only well within the limits of the Antarctic Convergence (Mackintosh, 1946, pl. i) but also within the limits of the pack-ice (Mackintosh & Herdman, 1940, pl. lxxv), so that the specimen may properly be said to be Antarctic in origin. The chart shows soundings within this area varying from 4260 to 4400 m. which means that the sperm whale must have taken the fish at some level in water which was at least 4260 m. deep. There is evidence that a Sperm whale may sound to 500 fathoms or 900 m. (Laurie, 1933) but it is possible, as will be seen later, that the fish may have been captured at a quite shallow depth.

Table 3. Ceratias holbölli *Kröyer*. *Distribution of known specimens*

Specimen	No. on Chart	Recorded by	Locality	Position	Depth of haul in metres or metres of wire out
		ADULT > 12 cm. standard length			
Ceratias holbölli	1	Kröyer (1844) (type)	Greenland	—	330
Ceratias holbölli	2	Lutken (1878)	Greenland	—	—
Ceratias holbölli	3	Lutken (1878)	Greenland	—	—
Ceratias holbölli	4	Goode & Bean (1895)	Nova Scotia	—	—
Ceratias holbölli	5	Saemundsson (1922)	Selvogsbanken, Iceland	—	140
Ceratias holbölli	6	Saemundsson (1922)	Selvogsbanken, Iceland	—	120
Ceratias holbölli	7	Regan (1925)	Iceland	—	—
Ceratias bolbölli	8	Schnakenbeck (1936)	Ingolfhöfdi, Iceland	—	—
Ceratias holbölli	9	Saemundsson (1939)	Kolluáll, Iceland	—	240
Ceratias holbölli	10	Rauther (1941)	—	—	—
Ceratias holbölli	11	Rauther (1941)	—	—	—
Ceratias holbölli	12	Bertelsen (1943)	West Greenland	—	—
Ceratias holbölli	13	Not previously recorded	Antarctic (Indian Ocean Sector)	Within 100 miles radius of 61° 20′ S, 102° 50′ E	?
Mancalias uranoscopus	14	Parr (1932)	Georges Bank, New England	—	—
		JUVENILE < 12 cm. standard length			
Ceratias n.sp.	15	Murray & Hjort (1912)	Atlantic, near Canaries	28 02′ N, 14 17′ W	—
Ceratias uranoscopus	*16	Murray (1877)	Atlantic, North of Cape Verde Is.	22 18′ N, 22 02′ W	4400
Typlopsaras shufeldti	*17	Gill (1883)	New England	—	—
Miopsaras myops	*18	Gilbert (1903)	Kauai I., Hawaii	*c.* 22 N, 160 W	900–1000
Mancalias uranoscopus	*19	Goode (1880)	Off south coast of New England	—	590
Mancalias uranoscopus	20	Regan (1926)	Caribbean Sea, near St Croix	17 43′ N, 64 56′ W	1000
Mancalias uranoscopus	21	Regan (1926)	Caribbean Sea, near St Croix	17 13′ N, 64 58′ W	4500
Mancalias uranoscopus	22	Regan (1926)	Atlantic	7 22′ N, 46 51′ W	600
Mancalias uranoscopus	23	Regan & Trewavas (1932)	South China Sea	19 19′ N, 120 13′ E	2000
Mancalias uranoscopus	24	Regan & Trewavas (1932)	North of Moluccas	4 10′ N, 127 44′ E	800
Mancalias uranoscopus	25	Regan & Trewavas (1932)	Indian Ocean, off Sumatra	3 06′ S, 99 15′ E	700
Mancalias uranoscopus	26	Regan & Trewavas (1932)	Indian Ocean	5 18′ N, 90 55′ E	3500
Mancalias uranoscopus	27	Regan & Trewavas (1932)	Atlantic	7 34′ S, 8 48′ W	2000–0
Mancalias uranoscopus	28	Norman (1939)	Arabian Sea	9 42′ N, 54 39′ E	2091–0
Mancalias uranoscopus	29	Beebe & Crane (1947)	Pacific, south of Cocos I.	4 50′ N, 87 00′ W	1370
Mancalias uranoscopus	30	Beebe & Crane (1947)	Pacific, south of Cocos I.	4 50′ N, 87 00′ W	1280
Mancalias uranoscopus	31	Beebe & Crane (1947)	Pacific, off Galapagos Is.	0 17′ S, 91 34′ W	910
Mancalias uranoscopus	32	Beebe & Crane (1947)	Pacific, off Galapagos Is.	0 17′ S, 91 34′ W	910
Mancalias uranoscopus triflos	33	Roule & Angel (1933)	Atlantic, Sigsbee Deep	40 15′ N, 56 25′ W	0–4000
Mancalias sessilis	34	Imai (1941)	Sagami Sea, east of Hasima	*c.* 35 N, 140 E	1220–0
Mancalias tentaculatus	35	Norman (1930)	South Atlantic	52 25′ S, 9 50′ E	650–700
Mancalias bifilis	36	Regan & Trewavas (1932)	East of Dunedin, New Zealand	46 43′ S, 176 09′ E	3000
Mancalias bifilis	37	Regan & Trewavas (1932)	Indian Ocean, east of Delagoa Bay	25 18′ S, 36 13′ E	2500
Mancalias xenistius	38	Regan & Trewavas (1932)	South China Sea	8 02′ N, 109 37′ E	1000

* Regan (1926) and Regan & Trewavas (1932) give *Mancalias uranoscopus* for nos. 16–19 inclusive.

HORIZONTAL DISTRIBUTION

The geographical distribution of *C. holbölli* is shown in Table 3 and Fig. 6. Bertelsen considered that *C. holbölli* was widespread in the tropical and subtropical parts of the ocean, but reserved his *C. tentaculatus* for more southern latitudes. Regan & Trewavas (1932, p. 13) similarly considered that

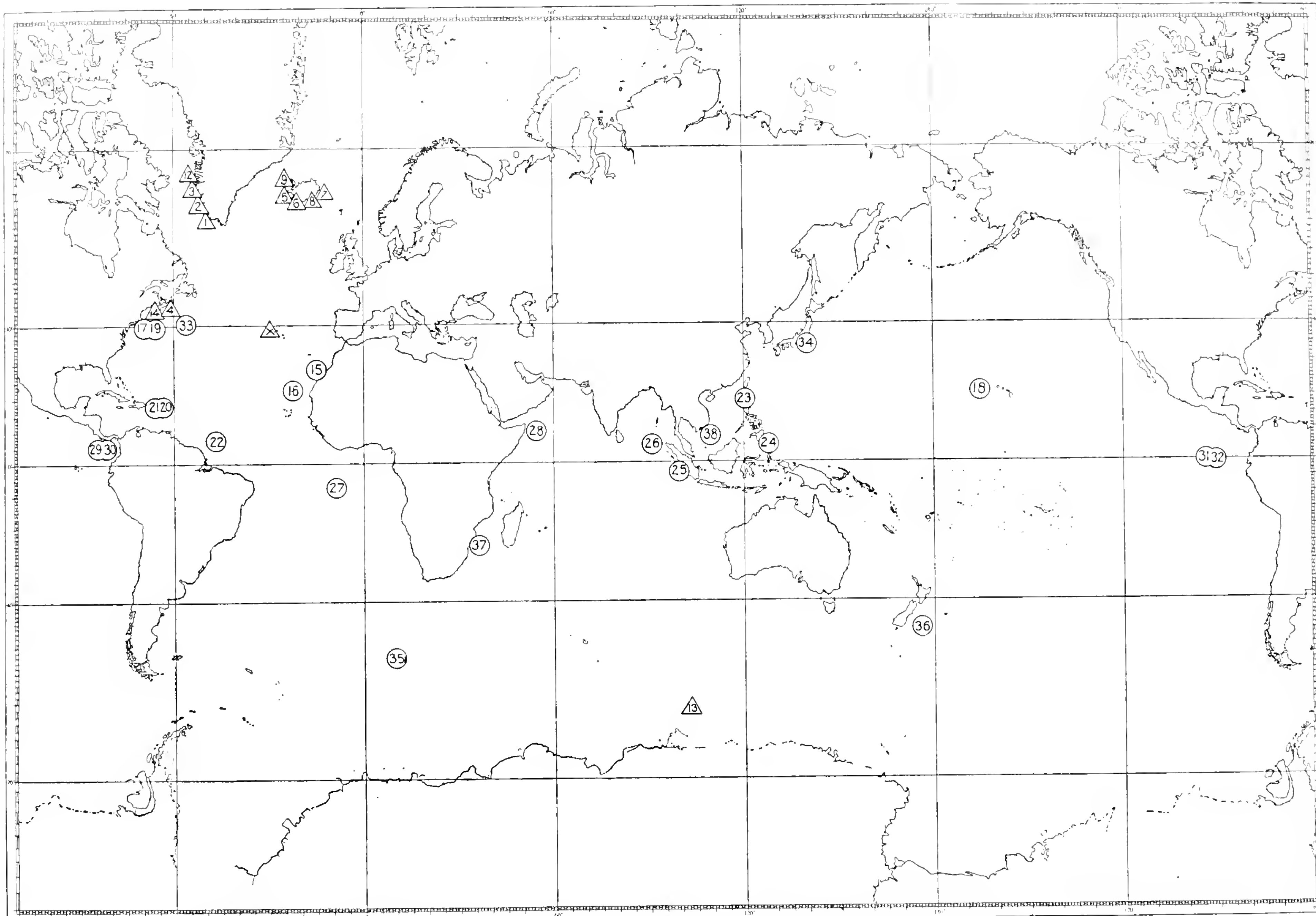


Fig. 6. *Ceratias holbölli* Kröyer. Horizontal distribution: adults △, juveniles ○, Azores record ⊠.

'*Mancalias uranoscopus*' was replaced in the south by distinct species. It is now seen that the single species *Ceratias holbölli* is a cosmopolitan form, dwelling in all the oceans and extending into polar latitudes, both north and south. A remark of Regan's referring to the Ceratioidea generally (1926, p. 10) may be recalled: '...it would be unsafe to predict that any species would not turn up anywhere.'

VERTICAL DISTRIBUTION

Regan & Trewavas (1932) and Gregory & Conrad (1936) both give the vertical distribution among Ceratioidea as 500–1500 m. Waterman (1938) extends the lower limit to 5000 m. However, with regard to *C. holbölli*, there appears no definite evidence that the species extends below 1000 m. In Table 3, the data showing depth of haul in metres, or metres of wire out, gives figures down to 4400 m.; but on only two occasions can one be certain that closing nets were used and that the specimens were not taken at some intermediate depth when hauling in the gear. Of these two hauls, the deeper was made in the tropical latitude of Hawaii (22° N) at 900–1000 m. when specimen no. 16 (Table 3 and Fig. 6) was obtained. The upper limit of the range is to be found in high northern latitudes off the coasts of Iceland and Greenland, where fishing trawlers took at least nine of the thirteen adults recovered from the northern hemisphere. Soundings are only available in connexion with four of these trawled fish; they were taken in water between 330 and 120 m. deep (Table 3). Any of these specimens may, of course, have been captured somewhere between these depths and the surface. That such fishes, taken in comparatively shallow water, were probably not moribund nor 'out of their depth', is suggested by the presence of a freshly swallowed *Gadus esmarki* in the stomach of one of them (Saemundsson, 1922). This appears to indicate a normal feeding migration.

The known bathymetric range of *Ceratias holbölli* is thus from 1000 to 120 m. or less from the surface. This range implies a tolerance of extensive changes in hydrostatic pressure which the fish, lacking the embarrassment of a swim-bladder, would appear well fitted to possess.

TROPICAL SUBMERGENCE

The presence of *C. holbölli* so near to the surface in high northern (and possibly southern) latitudes can be explained, as in the case of certain other bathypelagic fishes, by the phenomenon of tropical submergence (Hjort, 1912, p. 623; Sverdrup, Johnson & Fleming, 1942, p. 849). This would also account for the widespread distribution of the fish and its vertical range. *C. holbölli* in the high latitudes of both hemispheres probably has a normal vertical distribution from considerable depths nearly to the surface, but its upper limit is increasingly submerged with approach to the equator. Table 3 shows that in the tropics it has been taken at 900 to 1000 m., but it has never in such latitudes appeared in a haul made from less than 600 m. Probably, for any one latitude, its known vertical range of around 1000 m. is only attained in the polar seas, north and south. When near the surface in these regions it would be normally over the deep ocean, which explains why it has been so seldom captured by the Arctic trawlers, since they fish only the neritic seas and would only take occasional specimens which have strayed on to the continental shelf.

Tropical submergence is usually attributed to the distribution of temperature and (to a lesser degree) of light, in the ocean. Viscosity is doubled by a 25° C. fall in temperature (Sverdrup *et al.* 1942, p. 69), and it has been pointed out that the viscosity of the water is important in limiting the vertical distribution of certain copepods and small bathypelagic fishes (Hjort, 1912, p. 698; Coe, 1946). With regard to *C. holbölli* it can be argued that even a fish of this size is perhaps limited to water of high viscosity, because its sluggish habit requires an environment which will allow maximum support with the least expenditure of muscular activity. The sluggish habit is suggested by the clumsy shape of the fish, its poorly developed body musculature and the condition of the fins; of the latter, the pelvics are absent,

the pectorals much reduced, and the caudal, although large, yet palmate and weakly constructed.* Such a fish might, in low latitudes, be confined to the deeper cold water; towards the poles, where the temperature differs little throughout the water column, it could approach nearer to the surface.

Light intensity as a barrier to vertical range may, in this context, be even more important. Hjort (1912, p. 664) has written 'in different waters the upper limit for black fish and red crustaceans seems to coincide with the same low intensity of light', and Sverdrup *et al.* (1942, p. 851) have also noticed this direct effect of light upon certain bathypelagic organisms. The reduction and effective concealment of the eye during the ontogeny of *C. holbölli* strongly suggests that the fish is nicely adjusted to the intensity of light in its environment. It is probably adapted to surroundings of near or complete darkness, and consequently must suffer submergence in the tropics, but could rise much nearer to the surface, from the bathypelagic to the mesopelagic zone, progressively farther north and south as the intensity of illumination decreases. There is also the possibility of a superimposed diurnal rhythm which would bring the fish nearest to the surface at night.

With regard to this matter there exists direct evidence that, in a high latitude, a bathypelagic fish can make an apparently normal feeding migration to within a few feet of the very surface of the ocean. For this information I am indebted to Dr N. A. Mackintosh, who observed the fish at St WS 540, on 27 January 1931, when the R.R.S. 'William Scoresby' lay alongside pack-ice east of the South Sandwich Islands in 57° 55′ S, 21° 21′ W. This was in the region of the South Sandwich Trench over water between 4000 and 5000 m. deep. In the 17th Scientific Report from the 'William Scoresby', 1931 (unpublished), Dr Mackintosh records:

'It is noteworthy that during the night, when the ship was stopped and the wind fallen away, an eel-shaped Stomiatoid fish, with brilliant luminous organs and silvery scales, was feeding on the krill close to the surface, and could be plainly seen by the light of a cargo cluster. We attempted to catch it with a hand net, but without success.'

The Biological Deck Log contains a further note by the late E. R. Gunther describing the feeding activity. Although not strictly relevant it seems worth recording here.

'From a pair of luminous organs in the orbital region, the fish (which was 9–12 inches in length) emitted a beam, of varying intensity, of strong blue light which shone directly forwards for a distance of about two feet. The fish had the habit of lurking at a depth of 2–6 feet below the surface, poised at an angle of about 35–40° from the horizontal—this gave the beam an upward tilt: occasionally the fish swam round and with a quick action snapped at the cloud of krill above it.

'In its manner of lurking and of snapping prey it resembled the freshwater pike. From the anal region was seen to trail a length of brown substance which, it was supposed, might have been either genital or faecal product.'

Bertelsen has noticed that several large representatives of the genera *Himantolophus*, *Oneirodes* and *Cryptopsaras*, all of them known to have a more southerly distribution, have been recorded from water over the continental shelf of Iceland and Greenland. Tropical submergence, therefore, may be a feature of some other members of the Ceratioidea.

DISTRIBUTION AND OCEAN CURRENTS

Bertelsen, however, has advanced an explanation opposed to that of tropical submergence in order to explain the presence of *Ceratias holbölli* and the other Ceratioids just mentioned, in the shelf water of high latitudes. He considers that these large specimens are carried northward by the North Atlantic Current until they meet the Polar Current when they are forced by the cold bottom water to seek lesser

* Waterman (1948) notices similar characters in the Ceratioid *Gigantactis*, and, in its brain structure, finds further evidence of weakly developed locomotor activity.

depths and thus come within the range of the trawlers. Bertelsen, in fact, considers that *C. holbölli* is limited to comparatively warm water. Against this is set the capture of the Antarctic specimen in a water column which varies between limits of no more than 0·5 and 2° C. throughout its entire length. Moreover, at stations where *C. holbölli* has been taken, the only available temperature record at the level of a closing net haul, and therefore reliable in this context, is that for specimen 35, (Table 3, Fig. 6). This specimen, '*Mancalias tentaculatus*' Norman, was caught between 650 and 700 m. when the temperature recorded at 745 m. was 2·08° C. (*Station List*, 1929). According to Sverdrup *et al.* (1942, p. 658), the deep water of the North Polar Sea has a uniform temperature of about −0·85° C. However, the most northerly of the specimens from the coast banks came from west Greenland and were taken apparently south of the submarine ridge across the Davis Strait. The bottom water in this area is nowhere less than 1·7°, and the greater part of the column lies between 3·5 and 3·0° (Sverdrup *et al.* 1942, p. 663). Therefore, by comparison with the southern specimens, it does not seem likely that the specimens caught on the northern coast banks were there because they had been forced up by cold water.

Bertelsen supports his argument by reference to Jensen (1942), who maintains that species of the pelagic Sudiid fish, *Paralepis*, found in the same regions as the trawled specimens of *Ceratias holbölli*, represent adults which have drifted northwards from lower latitudes until the water becomes so much cooled that the *Paralepis* spp. are paralysed, 'becoming an easy victim to seals and fishes of prey, or they float dying or dead up to the surface of the water, and thereupon may drift ashore'. Jensen's evidence appears to be that post-larval *Paralepis* are found in warmer water than the adults, and that these adults are rarely taken in nets in northern latitudes, but do occur in the stomachs of seals, tunnies, coalfish and cod. The evidence that *Paralepis* drifts ashore dead seems to be confined to a missionary report, a single floating specimen found by Jensen, and one specimen washed ashore at Jutland in 1865. Contrary to Jensen's argument, it may be supposed that the presence of adult *Paralepis* in high latitudes is a natural part of their migrational distribution, and that, possibly assisted by their attenuated shape, they are able to avoid pelagic nets—but not predatory fishes. One may refer here to their southern congener, *Paralepis coatsi*, which is of circumpolar distribution in the Antarctic within the limits of the pack-ice (Norman, 1937). I notice that here also *adults* of this species have not appeared in the catches of oceanographical expeditions, whereas factory ship biologists, in their reports to the Discovery Committee, have repeatedly noticed adult* *Paralepis coatsi* in the stomachs of Blue and Fin whales. Their presence in the stomachs of these whales is undoubtedly fortuitous. Like the whales which happened to engulf them, these fish had been feeding on the shoals of adult and yearling krill (*Euphausia superba*) which, as I am informed by Mr J. S. Marr, for the most part live right at the surface, between 0 and 5 m.

Jensen's survey of the occurrence of *Paralepis* is thus open to a different interpretation which does not support Bertelsen's argument regarding *Ceratias*.

With so few specimens available, one can only speculate on what relation the known distribution of *C. holbölli* does, in fact, bear to the great ocean currents, north and south. Dykgraaf (1934) has shown that pelagic fish tend to drift or swim with the current, and not against it as formerly believed, so there seems no doubt that the sluggish adults of *C. holbölli* are as much borne by the currents as the juveniles are likely to be. If, as has been suggested, this fish in polar regions has a range from the middle depths to within 100 m., or even less, of the surface, then, in the Antarctic, any vertical migration within the upper part of this range would tend to keep it in a high southern latitude. It would move between the shallow Antarctic surface water, 0–200 m. thick moving towards the north, and the Warm Deep Current moving south (Mackintosh, 1937). During the low light intensity of the winter it might spend more

* Thirty-seven individuals, removed from the stomachs of Blue and Fin whales in the Antarctic season 1947–8, had a mean length (with caudal) of 29·7 cm., $\sigma = \pm 4{\cdot}1$.

time in the surface current, and so move northwards towards the Antarctic Convergence, until forced down in this region by either temperature or light barriers, or both, to continue north with the Antarctic Intermediate Current under the conditions of tropical submergence. With further submergence in a lower latitude this fish (or another generation) might find itself in the Warm Deep Current again and so be returned to the Antarctic (Deacon, 1937, fig. 1). Or it may enter the northern circulation, since Coe (1946) has suggested that there are areas, like the deep water off Bermuda (which has components of Arctic, Antarctic and Mediterranean origins), where bathypelagic animals may collect in eddies or be widely redistributed during the course of generations.

Nothing can be said concerning breeding in relation to these hypothetical drifts of *C. holbölli* except that reproduction is likely to take place in fairly deep water at a low latitude. This is suggested by the regressed condition of the ovaries in the Antarctic specimen and by the fact that sixteen of the twenty four known juveniles have been captured at stations within the tropics.

PERCEPTION IN *CERATIAS HOLBÖLLI*

Waterman (1948) has described the Ceratioid *Gigantactis longicirra* as a floating, bathypelagic trap. Even more so *Ceratias holbölli* deserves such a description, for the fishing lure in this animal, by its extreme adjustability, achieves a mechanical specialization and efficiency unequalled among the Ceratioidea. The very modifications of such a fish require that, if it is to survive at all, it must be furnished with adequate sensory apparatus. It needs to apprehend the presence of prey and so entice the latter into its mouth by retraction of the lure; and it must be able to sense the approach of predators. Yet the reduction of the senses of vision and olfaction, noticed by Waterman in *Gigantactis*, is carried even further in *Ceratias holbölli*, where the adult female is functionally blind and the nostrils are represented by vestigial tags. The problem, therefore, arises how the highly modified *C. holbölli*, apparently helpless to escape, and defended only by its prickles, can have been able to evolve as a fish blind when adult. Chun (1896) has indicated that luminous organs would betray their possessor to predators in its vicinity. The Sperm whale, whilst seeking the squid which are its normal prey, was presumably attracted in this way to the escal lamp of the Antarctic specimen. But it is conceivable that an angler fish, being aware of the approach of predators, could evade them by extinguishing the tell-tale light (Waterman, 1939*a*, 1948; Harvey, 1940, p. 161).

The means of this perception in the adult *C. holbölli* is at present obscure. Whilst discussing the attraction of males attention has been drawn to the evidence adduced by Brauer (1908) and Waterman (1948) of a sensory function subserved by the esca in *Gigantactis*. But it was pointed out that in *Ceratias holbölli* there are at most only two of those numerous filaments which characterize the esca of *Gigantactis* and which might be supposed to be sensory in nature. We must probably look elsewhere for the sensory apparatus in *Ceratias holbölli*. Now Waterman (1948) has shown by anatomical studies that the stato-acoustic system of *Gigantactis* is considerably developed. Probably a similar or greater development of this system is attained in *Ceratias holbölli*. Parker (1904) and Dykgraaf (1934) have emphasized a 'lateral line sense' supposed to make fishes aware of low-frequency movements in the water, so it may be that the lateral line organs on the head of *C. holbölli* are sensitive to local disturbances and that these are mediated with especial sensitivity.* By the amplitude of these disturbances the fish may be informed of the vicinity of greater or lesser animals, of predator or prey.

Of course this is supposition, but at least it may serve with whatever else is tentative in the present account to draw attention to the biological problems raised by only one, albeit the most specialized one, among this curious group of bathypelagic angler fishes.

* Similarly the blind group of amblyopsid Cyprinodonts show on the head and body a special development of papillae, believed to subserve perception (Norman, 1931).

SUMMARY

1. An adult female Ceratiid fish, 43·0 cm. standard length, was removed from the stomach of a Sperm whale shot in the Antarctic Ocean in December 1947.

2. It is identified as the rare bathypelagic angler fish, *Ceratias holbölli* Kröyer, 1844, by detailed comparison of the external features, fishing lure, caruncles and viscera, with Kröyer's account and with a specimen preserved in the Natural History Museum.

3. Adult specimens of this fish have previously only been recorded from the coast banks of northern seas. This adult is the first from oceanic water.

4. An observation on the adjustability of the fishing lure, made when the Antarctic specimen was recovered, confirms Bertelsen's conclusions from anatomical structure (1943). The musculature of the lure in *Ceratias* is compared with that in another Ceratioid genus, *Gigantactis*.

5. The viscera of *Ceratias* and *Gigantactis* are compared. In general they are similar, but *Ceratias* possesses two pyloric caeca; these are altogether lacking in *Gigantactis*. Neither genus possesses a swim-bladder.

6. The ovaries of the Antarctic specimen were regressed and contained very young eggs, suggesting a much restricted breeding season which may have been a major stimulus in the evolution of attached males for these solitary, sluggish fishes.

7. A study of allometric growth in *Ceratias holbölli* provides further evidence for Bertelsen's claim that the species of *Mancalias* are juveniles of *Ceratias*. The dimensions of thirteen specimens, representing 'species' of *Mancalias* and *Ceratias* are found to conform to the simple allometry equation $y=bx^{\alpha}$. The allometry of the various parts is described and its significance discussed.

8. In particular, the growth of eyes and nostrils is strongly negatively allometric. During ontogeny the tubular mostrils of the young fish suffer reduction to vestigial tags in the adult; and the conjunctiva of the eye is borne across the eyeball, which becomes subcutaneous, so that the adult is functionally blind.

9. In the young fish the caruncles are the only organs which clearly show positive allometry, but at about 12 cm. standard length caruncle growth becomes enantiometric and thereafter the caruncles dwindle in absolute size. The onset of this enantiometry is believed to betray a crisis in development, which is probably sexual maturity. The caruncles may be recognition marks for the males.

10. The systematics of *Ceratias* are discussed and revised, principally on the evidence of allometric growth. Bertelsen's southern species *C. tentaculatus* is considered invalid and the genus reduced to the single species *C. holbölli* Kröyer, 1844.

11. Parenthetically, it is emphasized that routine examination of Sperm whale stomachs could increase our scanty knowledge of the nektonic macrofauna. Some bathypelagic squids and fishes may be more common and grow larger than is at present supposed.

12. *C. holbölli* is of world-wide distribution, extending from equatorial to polar seas. Its known bathymetric distribution ranges from 1000 to 120 m. from the surface. This upper limit is only attained in high latitudes where the fish extends into the mesopelagic zone.

13. Tropical submergence can account for these aspects of horizontal and vertical distribution· Light intensity is considered to be more important than temperature as a factor limiting the ventrical range of *C. holbölli* at any one latitude.

14. Evidence is offered against the theory that *C. holbölli* and certain other fishes (notably *Paralepis* spp.), taken off the Greenland and Iceland coasts, have been forced towards the surface by the cold polar current. A tentative hypothesis is advanced regarding the distribution of *C. holbölli* in relation to the ocean currents, especially of the southern hemisphere.

15. The problem of sensory perception in the adult *C. holbölli* is discussed. The fish is functionally blind, and olfaction is considerably reduced. It is suggested that the lateral line organs are more likely than the esca to undertake this function of informing the fish of its environment.

POSTSCRIPT ON A RECORD FROM THE AZORES

Since the above account was written I am able to record, again from a Sperm whale's stomach, but this time from the Azores, a further adult specimen of *Ceratias holbölli*.

During my investigations on Azores whaling, conducted in the summer of 1949, the stomach contents of a certain Sperm whale (no. F 21, ♂, 16·0 m. long) were found to include a remnant of fish skin, about 600 sq.cm. in area, greyish black in colour and closely beset with spines. Any associated remains were too much digested and were not recovered.* The shape of the spines, and their arrangement in the skin, betrayed the latter as unmistakably belonging to a specimen of *C. holbölli*. The largest spines were 0·6 cm. high and 0·9 cm. across their shield-shaped bases. These measurements agree with those of Regan's specimen (p. 24) and suggest that the Azores individual was about the same size, i.e. around 100 cm. total length.

The whale was killed on 11 August 1949. I witnessed the harpooning and lancing, and noticed that a giant squid, vomited in the death-flurry, was quite fresh. The whale had therefore recently been feeding, and so it is likely that the angler fish had been swallowed within, say, a 5-mile radius of the position where the whale had been harpooned. The whaleboat was then about 20 miles south-west of Capelinhas Lighthouse, Fayal; this gives a position approximately 38° 21′ N, 29° 08′ W, and the chart shows soundings of between 1300 and 1700 m. within a 5-mile radius of this point. The record has been inserted in Fig. 6 and marked X, but it does not appear in Table 3.

The total number of recorded adults of *C. holbölli* (Table 3) now stands at fifteen; but only two of these, the Antarctic and Azores specimen, have been secured from oceanic water. Yet it is worth remarking that out of 106 Sperm whale stomachs I have examined to date, two contained *C. holbölli* among the ten stomachs which held fish remains of some kind or another. This not only seems a high incidence for what has previously been supposed to be a very rare fish (p. 3), but it also tends to support the view that the thirteen specimens from the coastal fishing banks happen to have strayed horizontally from their proper habitat in oceanic water (pp. 25, 27).

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* For this record I am entirely indebted to Senhôr José dos Reis, manager of the whaling station at Horta, Fayal. When the whale concerned was worked up I was still absent with the whaleboats, and Senhôr dos Reis kindly examined the stomach for me. He retrieved this dingy piece of skin and, with admirable forethought, kept it three days against my return.

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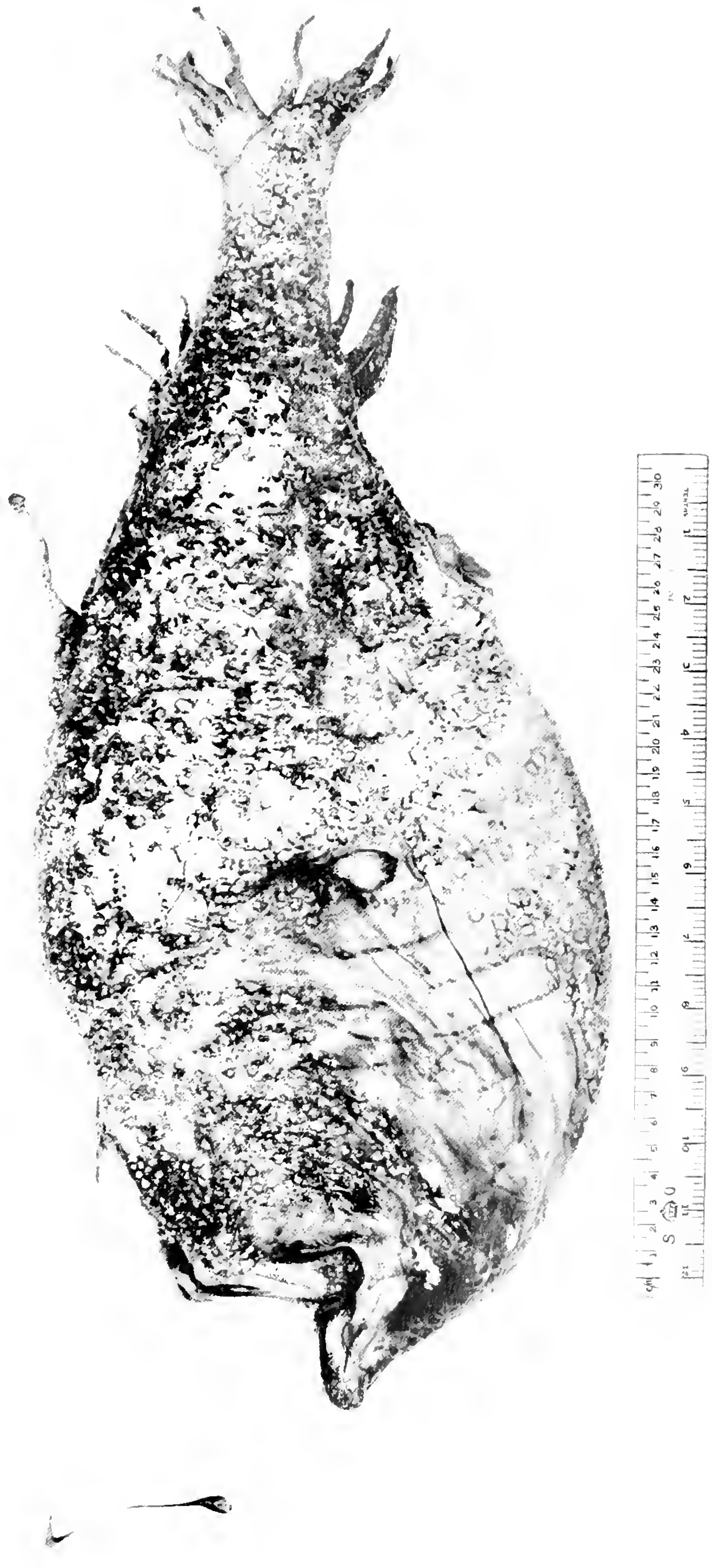
PLATE I

Ceratius holbölli Kröyer. The Antarctic specimen from a Sperm Whale's stomach.



[*Discovery Reports. Vol. XXVI, pp. 33–46, Plates II–IV, January 1951.*]

STYLASTERIDAE (HYDROCORALS) FROM SOUTHERN SEAS

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(Plates II–IV, Text-figs. 1–12)

SPECIMENS of Stylasterids (Hydrocorals) have been taken by the ships of the Discovery Investigations at only a few stations. The Stylasteridae are on the whole comparatively scantily represented in collections of deep-sea expeditions, because in localities favourable to their growth the nature of the bottom makes collecting difficult.

Nevertheless, the Discovery material is very interesting both from a taxonomic point of view, containing as it does a peculiar new genus and two hitherto undescribed species, and also from the zoogeographical data supplied by the localities. From two of the stations so much material was collected that some impression of variation in the species *Errina antarctica* (Gray) can be obtained. This species is evidently widely distributed in antarctic-subantarctic waters.

Errina (Eu-Errina) antarctica (Gray, 1872)

(Pl. II, fig. 1; Pl. IV, figs. 3–6)

Porella antarctica Gray, *Proc. Zool. Soc. Lond.* 1872, p. 746, pl. 64, fig. 4.
Labiopora antarctica Moseley, *Philos. Trans.* 1878, vol. 169, pp. 476, 480. Ridley, *Proc. Zool. Soc. Lond.* 1881, p. 105.
Errina gracilis von Marenzeller, *Rés. Voy. Belgica, Rapp. Sci., Zool. Anvers*, 1903, p. 4, pl. i, figs. 1–4.
Errina antarctica Hickson, *Proc. Zool. Soc. Lond.* 1912, p. 887. Hickson, *Bull. Mus. Hist. Nat. Paris*, 1912, p. 2 (462). Broch, *Skr. d. Norske Vid.-Akad. Oslo*, I. Mat.-Naturv. Kl. 1942, no. 3, p. 42, figs. 11, 12, pl. iv, fig. 12.

St. 652. Burdwood Bank, 54° 04′ S, 61° 40′ W, 169–171 m. Net badly torn (hard bottom).
St. 1948. 60° 49·4′ S, 52° 40′ W, 490–610 m.
St. 2200. Between Young and Sturge Is., Balleny Group, 67° 09·6′ S, 163° 27·7′ E, 532–512 m.
St. 2215. Off Antipodes Is., 49° 45·6′ S, 178° 48′ E, 163–210 m.
St. 2290. Off Falkland Is., 52° 16·6′ S, 58° 06·8′ W, 137–133 m.

The *colonies* of *Errina antarctica* are in most cases rather coarse and heavily built, fan-shaped with a distinct anterior and posterior side, the latter with none or only very few pores. The distal branchlets have numerous pores and spines on all sides (see Pl. II, fig. 1), but the spines tend to diminish and disappear on the posterior side, which may be naked and all but poreless already some 1 cm. from the top. The terminal branchlets carry spines on all sides and are cylindrical. They are differentiated into a zooid-bearing anterior and a naked posterior side, with more or less pronounced flattening of the branch, which in transverse section becomes more obviously oval, its greater diameter lying in the plane of the fan. In the basal parts of larger colonies spines and zooids disappear also on the anterior face of the main branches and stem. In many cases basal parts of the stem and main branches, where pores have disappeared, grow so broad that they coalesce into one flat basal stem or trunk.

It must be noted that the colonies may be partly incrusting. Whether a colony can spread over a large area cannot be answered with certainty, but part of a colony from the Burdwood Bank apparently has a horny black axis, because the hydrocoral has grown around the axis of a dead gorgonid and from this part real branches arise (Pl. II, fig. 1).

The material from Sts. 2200 and 2290 is especially rich, indicating the range of variation in the species.

The colony from the Burdwood Bank is on the whole very coarsely constructed like the colonies from St. 2200 (Pl. IV, figs. 3, 4 and 6). Colonies which are comparatively heavily built are almost always rather regularly flabellate, sometimes also a little incurved on the anterior side. On the other hand, colonies of more delicate construction and with marked ramification in many cases exhibit a more irregular growth and tend to have a more bushy appearance, although a main plane can still be distinguished (also from St. 2200, Pl. IV, fig. 5). An excellent figure of this type has been given by von Marenzeller (1903, pl. i, fig. 1) in his description of *E. gracilis*.

The branching is dichotomous or subdichotomous. However rich the branching may be, anastomoses are very seldom found.

The *colour* of the colony (in spirit) varies from a vivid brilliant carmine or brick red to almost white or yellowish, or occasionally light brown. Dead colonies may be greyish white, but very soon they attain a dark dull brown colour, probably owing to the attack of foreign micro-organisms. (Dead colonies are of course also exposed to attacks of boring animals. In living colonies, sections have revealed the occurrence of small, parasitic crustaceans lodged in 'ampullae', evidently caused by the parasites, but not visible to external examination. The identity of the crustaceans has not been established.)

The surface of the coenosteum after cleaning with sodium hypochlorite generally exhibits the peculiarly reticulated structure reminiscent of a lump of sugar; but in some colonies the structure is more vermiculated and feebly glossy. The differences are so small and gradual that they cannot be regarded as of taxonomic importance.

In a previous paper (1942) I distinguished provisionally a form *kerguelensis* from the typical form from Cape Horn. The scanty material suggested small differences in the surface structure of the coenosteum which, however, fell well within the range of variation. Another small difference was observed in the *gastrostyles*, which in the Cape Horn specimen were more slender and spine-like. This, however, must be looked on as an anomaly. Several gastrostyles from different colonies have been examined, and in the main they coincide with the fir-cone-like gastrostyles of the Kerguelen colony (1942, fig. 12), which are characteristic of *E. antarctica*. On the other hand, *E. spongiosa* Broch, 1942 may exceptionally show some external likeness to the coarsest colonies of *antarctica*.

Among the features separating these two suggested forms of *E. antarctica* the *ampullae* were also mentioned. In the Cape Horn specimen they protrude 'almost hemispherically on the surface', whereas in the Kerguelen fragment they 'are not visible on the surface of the branchlet', although belonging to the superficial layers of the coenosteum. Both fragments were from dried specimens, and it was not possible to ascertain the sex; however, I hinted that possibly the Cape Horn specimen might be a female.

In the present abundant material, several colonies occur in which ampullae cannot be seen externally, whereas in others they are very obvious, protruding like sections of a ball, and, moreover, in vividly red-coloured specimens they are emphasized by a yellow or whitish colour. Fractures reveal, however, that ampullae are present in great numbers in the peripheral layers of the coenosteum of the first-mentioned colonies. An investigation of the contents reveals that these colonies are males, whereas those with protruding ampullae are females.

All earlier descriptions have been based on dried specimens, and I took the opportunity to examine the soft parts in the rich material to hand.

The *gastropolyps* have from three to six (mostly four) small, thread-shaped tentacles, which exhibit pronounced extension and contraction.

In *antarctica* as well as in some other *Errina* species the dactylopores are of two types, viz. the niche- or slit-like dactylopores (grooves) of the grooved spines, and the small circular pores of the coenosteum

between the spines. In the terminal branches all intermediate stages occur (see Broch, 1942, p. 44), and von Marenzeller (1903) was accordingly inclined to consider the small pores only as developmental stages of the larger pores of the spines. It is impossible from examination of dried specimens alone to solve this question or to determine whether a real dimorphism exists. But investigation of the soft parts shows that the dactylozooids also exhibit a dimorphic development correlated with the type of pore. The dactylozooids inhabiting the simple pores of the coenosteum are digitiform (Fig. 1) and lack a specially developed basal adhesive part attached to the bottom or wall of the pore. The dactylozooids of the 'large pores', or grooves of the spines on the other hand, have a long basal segment attached to the wall of the lower part of the groove and the outer part of the adjoining pore, the digitiform, free part of the dactylozooid arising from the middle of the basal segment (Fig. 2). In the Discovery specimens the contracted free part is shorter than the basal segment, and it is impossible to judge of its length when extended. We must, however, presume that its powers of extension are rather large.

Figs. 1, 2. Errina antarctica from St. 652. (1) Simple, digitiform dactylozooid from pore between the spines. (2) Dactylozooid from the groove of a spine; the digitiform, free part of the zooid (z) arises from the middle of a large, adhesive basal part (b). × 80.

Thus it appears that a real dimorphism exists among the dactylozooids of *E. antarctica* correlated with the dimorphic development of the dactylopores.

The *male* ampullae contain a few gonophores (generally three) in different stages of development. When one gonophore is quite ripe and about to discharge its contents, the smallest (third) gonophore is only a rudimentary bud. No blastostyle can be detected in the ampulla. In this respect *E. antarctica* obviously differs from *E. spongiosa* Broch, 1942. The spadix of the male gonophore varies somewhat in shape, but always seems to be branched. In some cases it forms a very primitive 'trophodisc', whereas in other cases it is bi- or trifurcate, with the branchlets embedded in the contents of the gonophore.

The *female* ampulla only contains one gonophore. In those ampullae which were either empty or contained planula larvae about to escape, no secondary gonophores were seen. This may of course be a chance observation. The ripe ovum rests on a slightly hollowed bowl-shaped trophodisc, which in structure is intermediate between the trophodiscs of *Stylaster rosens* and *S. gemmascens* (Broch, 1942).

It is evident from the general characteristics of the colonies and the coenosteum that *Errina gracilis* (von Marenzeller, 1903) is a synonym of *E. antarctica*, and there is no reason to distinguish a form *kerguelensis* (Broch, 1942) as distinct from the typical form of the species.

Errinopsis reticulum n.gen., n.sp.

(Pl. II, fig. 2; Pl. III, figs. 1, 2)

St. WS 246. South of Falkland Is., 52° 25′ S, 61° 00′ W, 208–267 m. Coarse green sand and pebbles.

The Discovery material consists of four colonies, luxuriant but not quite intact, and several fragments (probably broken away from the peripheral parts of the colonies). The largest colony, a splendid specimen with the greater transverse diameter measuring 32 cm. and a height of 25 cm. (the basal part with the attachment to a support has been broken away) is dried, consequently the two colonies next in size, one male and one female, which have been preserved in alcohol, have been selected as type specimens. They are reproduced in Pl. II, fig. 2, and Pl. III, fig. 1.

As indicated by the specific name *reticulum*, the colonies throughout have the appearance of a simple or complex fan, built up of a coarse network or filigree of anastomosing branches. Along the periphery

of the colony, where branchlets bud, the terminal parts of the branchlets very soon touch and also coalesce to form new meshes. Terminal branchlets may have a diameter of only about 1 mm., but they soon grow thicker, and the diameter of the branches generally increases to 3–4 mm., in some cases even to about 5 mm. The meshes commonly have diameters of some 3–8 mm., and the size of the meshes is fairly constant in older parts of the colony. During growth the branches become oval in transverse section, the greater diameter being perpendicular to the main plane of the flabellum. In older parts of large colonies the greater diameter may often exceed twice the shorter diameter in length.

Accessory fans are common in older colonies. Such secondary fans diverge more or less strongly from the plane of the mother fan and are attached to the latter along the greater part of one side. In some cases a secondary fan may attach itself by its entire periphery to the mother fan, so that a closed 'basket' is formed, generally with finer meshes than in other parts of the old colony. The photographs on Pl. II, fig. 2 and Pl. III, fig. 1, convey the general features more clearly than any description.

The largest dried colony has a continuous accessory fan formation along the entire lateral and upper peripheral part, and the colony appears about to split along a line some 3–7 cm. within the margin into two somewhat diverging fans.

Under the microscope the surface of the colony gives a general impression of being finely reticulated. However, when cleaned with sodium hypochlorite the coenosteum becomes rather glossy, and its surface then exhibits a more vermiculated structure strongly reminiscent of a fingerprint (Pl. III, fig. 2). In places this vermiculated structure, owing to greater irregularities in the lines, presents a more reticulated appearance, but in all cases the surface keeps its semi-glossy character and does not give the 'lump of sugar' impression of the *Eu-Errina* species described by Broch in 1942.

The internal structure of the coenosteum is almost homogeneous, approaching to a certain degree the compact porcellaneous consistency of the *labiata* group of *Errina*. On the other hand, the central part with somewhat thicker branches is lighter in colour than the peripheral layers, and in some cases the axial part is all but white. In accordance with the comparatively porcellaneous appearance, the coenosteum is rather hard, and grinding is not so easy as in most of the *Eu-Errina* species. It must be added that there are no coarser canals in the oldest and thickest branches.

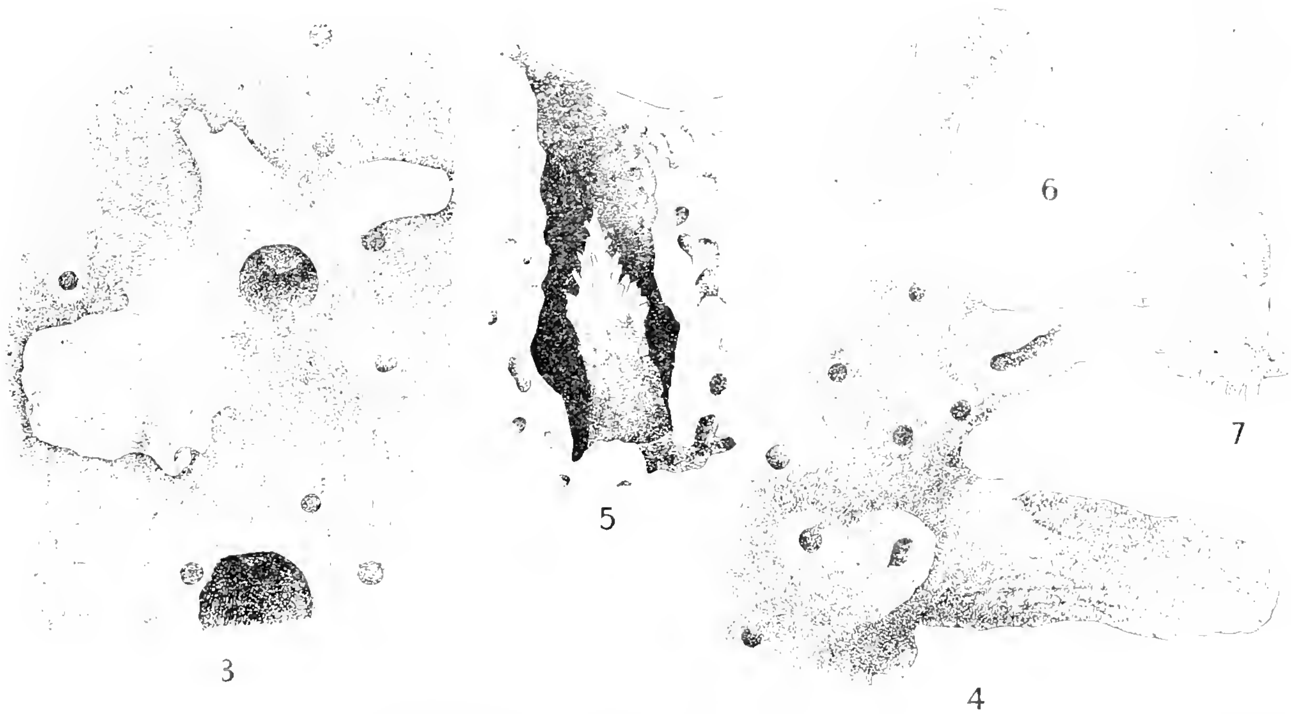
No correlation between the position of gastropores and dactylopores can be traced. The *gastropores* are rather small, their diameter at the opening measuring only 0·3–0·4 mm. The pores are also not particularly deep, and the well-developed gastrostyle is easily observed externally in colonies cleaned with sodium hypochlorite (Fig. 3). The gastrostyle (Fig. 5) resembles a pine cone with rather bristling scales, although it is comparatively compactly constructed. The cone is placed on top of a fairly high pedicle with smooth walls. Occasionally a gastrostyle was observed having an almost needle-shaped prolongation of the apical part of the cone.

It is impossible to discern any regularity in the distribution of the gastropores in peripheral free branchlets. In older branches, on the other hand, the great majority of gastropores are found along the lateral sides facing the meshes, whereas the anterior and the posterior sides of the branches (the flabellum) have only a few gastropores. The numbers are also smaller on the posterior than on the anterior side of the colony.

It has already been mentioned that no regular correlation between gastropores and *dactylopores* can be traced. Nevertheless, from one to three or four spines are almost always formed at the opening of the gastropore, each spine with one or more dactylopores (Fig. 3). In some cases such spines are wanting, and in others dactylopores occur in great numbers between the spines and independent of them. On the peripheral branchlets spines are numerous and equally developed on all sides. When the branchlets grow thicker, the spines seem to diminish, or to disappear little by little, first on the posterior and subsequently on the anterior side of the colony. Along the sides of the meshes, however, spines

are present also in older parts of the colonies, although they are more prominent on the thinner, apical or peripheral, branchlets than on more central branches of the meshwork (Pl. II, fig. 2; Pl. III, fig. 1). These features seem to indicate that the spines are gradually absorbed by the growth of the surrounding coenosteum, and that they do not grow materially after the incorporation of the branchlet in the meshwork of the colony.

At first glance we might presume dimorphism to exist among the dactylopores, small dactylopores being found as circular holes in the coenosteum in great numbers between the spines (Figs. 3, 4). On the other hand, it is obvious that the spines do not quite correspond either to the nariform or the waterspout-like spines of *Errina*. In their disposition, especially on the branchlets, they are reminiscent of the nariform spines of *Eu-Errina*, but it is also evident that they are connected with, or probably



Figs. 3–7. **Errinopsis reticulum** from St. WS 246. (3) Part of the surface of a branch; near the brim of the central gastropore three 'spines' are seated, the lumpy one with two grooves or conduits from base to summit. (4) Lateral part of a branchlet with full-grown and developing spines. (5) Gastropore from the fracture of a branch showing the entire gastrostyle in side view. (6) Gastropolyp *in situ* drawn on basis of two slides. (7) Gastropolyp prepared out. (1), (2) and (3) after skeleton having been cleaned with sodium hypochlorite; (4) and (5) from decalcified fragments. (1) × 40; (2) (5) × 60.

developed from, spineless pores by growth of the surrounding coenosteum (Fig. 4). The growth is not symmetrical, but at first results in a spine with an obliquely placed, oval pore-opening. In many cases the apical part of the spine grows far above the pore, so that this becomes an oval opening or slit on the side of a conical spine. In other cases the pore continues as a groove or narrow conduit to the very top of the spine. Again, two or three pores may debouch on one spine, and here one may be round, the other more groove-like. In Fig. 3 the lumpy spine is furnished with two grooves, both of which run conduit-like to the very summit of the 'spine'.

A careful examination of the coenosteum alone does not furnish a safe basis for determining whether the dactylopores exhibit real dimorphism. This question can only be settled by examination of the soft parts of the colony.

The *dactylozooids* are throughout simply finger-shaped without any specially developed basal adhesive part; they agree entirely with the smaller dactylozooids of *E. antarctica* (Fig. 1). The uni-

formity of the dactylozooids and the many intermediate forms bridging the differences between simple and spiniferous pores furnish evidence that dimorphism does not exist.

The small *gastropolyps* (Figs. 6, 7) are tubular and have four to six rudimentary small tentacles which are exceedingly difficult to trace in contracted specimens.

Both male and female colonies are found in the Discovery material. The male colony (Pl. II, fig. 2) is much lighter coloured than the female (Pl. III, fig. 1). This, however, may be fortuitous. On the other hand, although the male ampullae are placed rather superficially on the branches, there is no external indication of their presence, whereas the female ampullae are generally marked by lighter coloured or whitish spots on the branch or, in many cases, also by feeble swellings. Nevertheless, the ampullae do not show as protuberances among the pores or spines.

The *male* ampulla contains two to four gonophores, one of which may be fully ripe, whereas the second is less advanced in its development, the other gonophores being very small or quite rudimentary. In half-ripe gonophores, where the spadix attains its greatest development, the spadix is saucer-shaped with a small varying number of pouches or lobes, i.e. it is a simplified 'trophodisc'. The gonophores bud from the basal part of a finger-shaped blastostyle similar to that observed in *Distichopora violacea* (England, 1926) or *Errina spongiosa* (Broch, 1942), the agreement with the latter being especially marked.

While the male ampulla does not generally exceed 0·5 mm. in diameter, the ripe *female* ampulla has a diameter of about 1 mm. or even a little more. As a rule only one ovum develops at a time in the ampulla. No detailed study of the development of the gonophores was made, but they do not appear to differ from the common types of gonophores among Stylasteridae (Broch, 1942).

The present species cannot be assigned to any previously described form among the Stylasteridae. The irregular distribution of gastropores and dactylopores proves that it belongs to the subfamily Sporadoporinae, and the spines connected with several of the dactylopores, together with the arrangement of these spines in terminal parts of the branches, suggest the genus *Errina*. However, a thorough examination of the spines reveals that they differ from the regular spine types of *Errina*, from both the nariform spines of *Eu-Errina*, and from the 'waterspouts' of *Labiata* (Broch, 1942).

Above all, the colony is rather aberrant in its mode of growth. In some species of *Errina* various authors have emphasized the occurrence of more or less incidental anastomoses between adjacent branches of the colonies and used this as a specific characteristic. In the present species it is difficult to detect a free branchlet even at the periphery of the net-like colony, and the growth form of the new species seems to occupy a position among the Stylasteridae similar to that of the *Retepora* colonies among the Bryozoans. It is accordingly reasonable to regard this mode of growth and branching as a generic character, a point of view which to a certain degree is strengthened by the features of the spines and their above-mentioned independence of special dactylopores and dactylozooids. It is probable that the latter character should be more properly regarded as a specific feature. To settle this question, however, comparison with other related species is needed.

Hence the specimens can be regarded as the representative—and type—of a new genus,

Errinopsis n.g.,

the characteristics of which at present coincide with the genotype:

Errinopsis reticulum n.sp.

Colony simple or composite flabelliform, the branches anastomosing to form a regular, fine meshwork. Gastropores and dactylopores irregularly scattered on all sides of the terminal branchlets; in older parts of the branches the numbers of pores, and especially of dactylopores, diminish. Spines

are numerous on all sides of the terminal branches, but disappear gradually on the posterior and anterior sides of the branches towards the central parts of the flabellum, although they are present along the sides of the meshes in older parts of the colony. Surface of the coenosteum vermiculated, without nematophores. Gastrostyle pine-cone shaped with bristling spines. Dactylostyles wanting. Dactylozooids monomorphic, gastropolyps with four to six rudimentary tentacles.

Conopora pauciseptata n.sp.

(Pl. IV, figs. 1, 2)

St. 2493. 42° 03·9′ S, 00° 03·5′ E, 472 m.

Only a single fragment of a colony (Pl. IV, figs. 1, 2) was found in the catch. The main stem is 23 mm. high with a basal greater diameter of 6 mm. Only the basal parts of broken side branches have remained; their arrangement and construction show that the ramification has been in one main plane, and the stem and branches of the fan exhibit a distinct anterior side with numerous cyclosystems in one main row, whereas the posterior side is devoid of cyclosystems. On the other hand, the stem and branches also have lateral rows of cyclosystems along both sides towards the anterior side.

The surface of the coenosteum exhibits a peculiar vermiculated or striated structure, which is conspicuous before cleaning with sodium hypochlorite, and which is reminiscent of a finger-print, the same structure observed in *Errinopsis reticulum* (see Pl. III, fig. 2), but even more conspicuous in the present species. The finer lines are caused by rows of microscopic pores in the coenosteum through which the surface epithelium communicates with the tissues of the intersecting canals of the stem and branches.

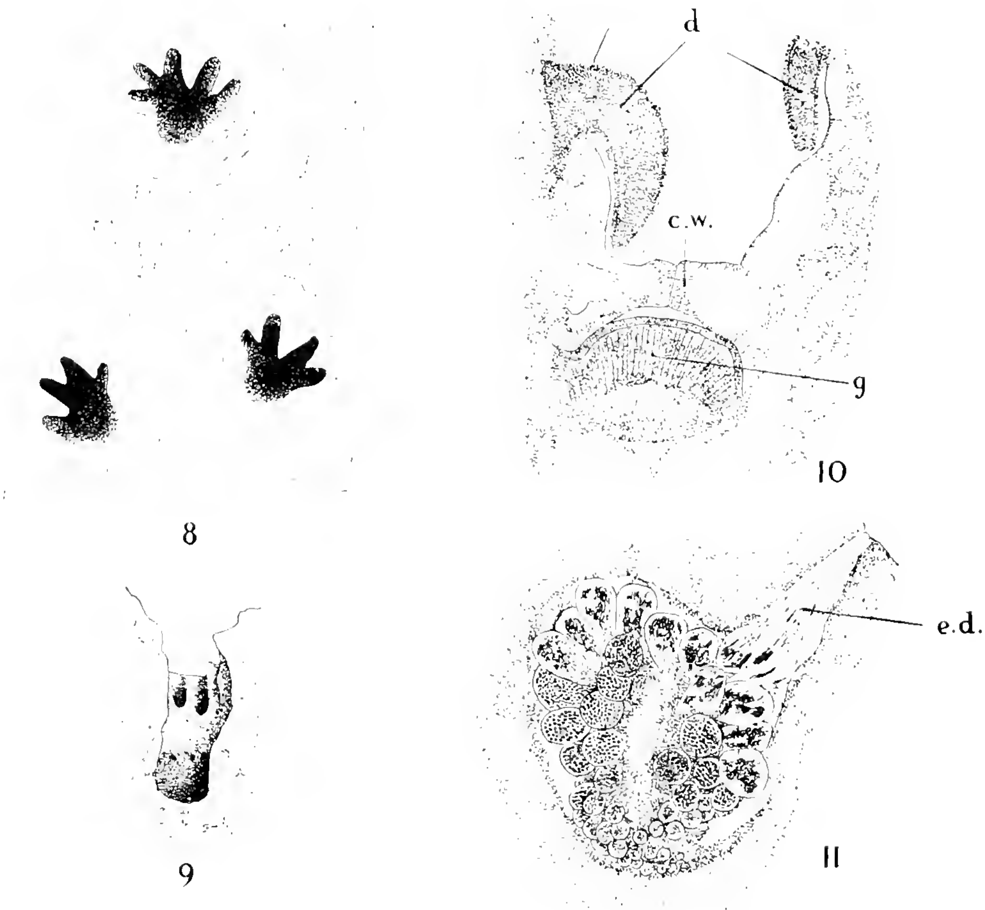
The coenosteum is not so hard as in most *Stylaster* species, but is softer and more easily ground, and although it is not so porous as in the species of *Conopora* previously investigated it compares well with their somewhat more compact construction. The fragment shows no indications of symbiotic worms, but this may be fortuitous. The dimensions indicate that the fragment comes from an old and rather large colony, and one might at all events have expected to find traces of the said symbiosis. This is the second *Conopora* colony observed without symbiotic worms, and it is of interest to note that the ramification and general flabellate shape of the two colonies agree (Broch, 1942, p. 88, pl. xiii, fig. 37*a*), although they evidently represent different species.

The *cyclosystems* of the median, anterior row of the stem and branches have on the whole many fewer dactylopores than the lateral systems. The accompanying table gives a variation from 3 to 6 (average 4·5) in the anterior row, whereas the lateral rows show a variation from 5 to 11 dactylopores (average 8·1).

Numbers of dactylopores ...	3	4	5	6	7	8	9	10	11	Total
Anterior row	2	4	4	2	—	—	—	—	—	12
Lateral rows	—	—	1	2	6	11	6	2	2	30

Complete cyclosystems occur apically on the branchlets; otherwise a single, complete system may quite exceptionally be found on the lateral rows. Generally, however, a diastemma is developed at the upper (adcauline) side (Fig. 8). It is not possible to state with certainty whether this diastemma exists from the beginning. But its mode of distribution in the different cyclosystems indicates that a diastemma is caused by and developed during growth of the coenosteum (the colony), and that the growth of the coenosteum gradually obliterates the adcauline dactylopores, whereas the abcauline side of the cyclosystem remains unaltered. In this way the number of dactylopores will also diminish, a fact consistent with conditions in the Discovery colony fragment.

These characteristics obviously differ from those species of *Conopora* previously described. In the latter the cyclosystems are complete and regular, although one (or two) of the adcauline 'teeth' between the dactylopores in *C. major* (Hickson & England, 1905) tend to develop more strongly than the others, thereby linking the genus *Conopora* to *Crypthelia* (Broch, 1936, 1947). This, however, is fundamentally different from the present case, where some of the adcauline dactylopores evidently disappear, whereas no indication of a 'tongue' can be traced, which might be parallelized with the tooth of *Conopora major* or the lid of *Crypthelia*.



Figs. 8–11. Conopora pauciseptata from St. 2493. (8) Part of the anterior side of the stem with two cyclosystems of the median row and one 'displaced' (lower left) at the basis of a branch. (9) Gastropore in side view from a ground section; dactylotomes and lower openings of the dactylopores visible. (10) Median section through the cyclosystem of a decalcified specimen. *d*, dactylozooids; *c.w.* wall epithelium of the chamber wall closing over the gastropolyp, *g*. (11) Section through a male ampulla with its efferent duct, *e.d.* (8) and (9) ×20; (10) and (11) ×60.

A comparison of the cyclosystems of the Discovery fragment with those of the previously known *Conopora* species furthermore reveals that the numbers of dactylopores are remarkably reduced. In *C. tenuis*, Moseley (1878; Broch, 1936, p. 87) found in 128 cyclosystems an average of 15·45 dactylopores (variation from 12 to 19), and in *C. major* in 72 systems 13·22 dactylopores (variation from 9 to 16). In the Discovery species the table (p. 41) shows a total variation in the present fragment (42 systems counted) from 3 to 11, with an average of 7·07 only. The fragment thus occupies an extreme position as to numbers of dactylopores in the cyclosystems.

The diameters of the cyclosystems generally measure some 0·6–0·8 mm. In terminal branchlets the

cyclosystems are evidently larger, and their diameter may here (in complete systems) attain a length of about 1·1 mm.

The *gastropore* is fairly deep and so arched that the lower part of its longitudinal axis is almost parallel to the axis of the stem or branch. The upper part of the pore is feebly narrower than the lower. The lower apertures of the dactylopores are found as minute round pores just beneath the feeble ledge limiting the 'basal chamber' from the narrower, funnel-shaped distal part of the gastropore. No sphincter is developed between the two compartments.

The *dactylopores* have large distal and small basal apertures. A great dactylotome, about half as long as the wall of the outer compartment of the gastropore, connects the dactylopore distally with the gastropore (see Fig. 9).

Ampullae are not visible externally on the fragment.

A small piece of the specimen was sacrificed for examination of the soft parts.

The surface of the colony is equipped with numerous small nematophores which appear as round spots. Under the microscope a mass of large stinging capsules is seen, larger and obviously different from the small capsules of the dactylozooids. Fixation of the material, however, is not good enough to allow of closer examination of the types of capsule.

The polyps are of course contracted (Fig. 10). The *gastrozooids* are globular with no trace of tentacles. The epithelium of the wall of the lower gastropore chamber can close sack-like over the contracted zooid (Fig. 10, *c.w.*), and at the same time the large, finger-shaped *dactylozooids* are doubled down, their tips in many cases reaching to the closed sack. The adnate basal part of the dactylozooid is comparatively small, being only a little broader than the basal breadth of the zooid.

The fragment is from a *male* colony. The ampullae are completely embedded although placed near the surface of the stem and branches. They are furnished with a well-developed efferent duct (Fig. 11, *e.d.*), which in most cases opens into the outer part of the cyclosystem funnel, a little outside (above) the dactylozooids. The ducts may open anywhere on the surface of the colony.

Owing to the scanty material only one series of rather thick sections in celloidin was examined. Details of the gonophores can therefore not be given. The ampulla contains one large 'blastostyle' carrying a great number of small gonophores (Fig. 11); the apical gonophores, placed next to the efferent duct of the ampulla, have ripe spermia, whereas the basal ones are as yet only quite rudimentary buds. The production of gonophores evidently continues for some time, spent gonophores being successively replaced from the basal part.

The present specimen diverges strongly from *C. tenuis* and *C. major*, but is definitely more closely related to *C. dura* (Hickson & England, 1908). However, the description and drawings of the last-named species reveal differences, which do not indicate specific identity. Both species have numerous small nematophores on the surface of the colony; but in *C. dura* the authors say that the nematophores have 'slightly raised lips', and such lips are wanting in the Discovery fragment. The surface of *C. dura* is characterized as 'smooth' (in the drawing it seems punctuated), whereas the Discovery specimen has an obviously and peculiarly vermiculated surface.

In the cyclosystems we find that those in *C. dura* are 'irregularly distributed on all sides of the branches and main stem', whereas the present colony has a naked posterior side and the cyclosystems arranged in rather distinct rows laterally and anteriorly. Although the shape of the cyclosystems in *C. dura* is characterized as 'irregular', the drawings show that they are complete without any diastemma in the dactylozooid circle. The drawings also indicate that the mouth of the cyclosystem in *C. dura* projects a little over the surface of the coenosteum. These are differences which distinguish *dura* from the Discovery specimen, which also has no horizontal septum between the upper and lower chambers of the gastropore, the limit being only feebly emphasized by a rudimentary ledge, on the lower side

of which a row of small pores occurs, through which the gastropore and the lower part of the dactylopores communicate.

Although at present the full range of variation in the species of the genus *Conopora* is not known, it seems most probable that the specimen from the Discovery material represents a hitherto undescribed species, the features of which may be summed up as follows:

Conopora pauciseptata n.sp.

Colony flabellate (?). Stem and main branches with cyclosystems in three main rows along the anterior and lateral sides. Surface vermiculated, with numerous small nematophores. Cyclosystems complete only terminally on branchlets, elsewhere embedded and incomplete, with an adcauline diastemma in the dactylopore circle. Gastropore with a feebly broader lower chamber separated from the funnel-shaped narrower upper chamber by a circlet of small pores, through which the dactylopores communicate with the gastropore. Dactylotomes about half as long as the wall of the upper gastropore chamber. Dactylopores in the (incomplete) cyclosystems of stem and branches number 3 to 11 (average about 7·07).

ZOOGEOGRAPHICAL REMARKS

Up to the present species of the genus *Errina* have only been reported from antarctic and sub-antarctic (antiboreal) waters. The Discovery Expedition has added one species of a closely related genus, *Errinopsis*. It is of interest at this point to review the antarctic and sub-antarctic data as a whole and in connexion with the comparatively rich Discovery collections, and to compare them with data from other regions.

According to our recent knowledge (Broch, 1942) the genus *Errina* must be regarded zoogeographically as a southern genus, the overwhelming majority of specimens deriving from sub-antarctic waters, and it seems reasonable to assume that the genus must have originated in this region.

It is very difficult to determine the species of this genus. Their distinguishing characteristics are in many cases seemingly of minor importance, and Hickson (1912), moreover, observed great variation in his comparatively abundant collections of the species *E. novae-zealandiae*, which he accordingly split into several 'facies'. However, like previous investigators of Stylasteridae, Hickson did not take into account those subtle characters which have proved to be of the greatest importance as a specific *fundamentum divisionis* in several cases, and his 'facies' seem to be more in the nature of casual growth forms of colonies, probably caused by ecological conditions.

It is accordingly of interest to note that the 'small' characteristics of the species *E. antarctica* are obviously stable. Colonies, the surfaces of which have in places been more strongly eroded, may at first give an aberrant impression. However, branch ends intact with undisturbed surface and intact spines exhibit all the typical characters and do away with every doubt as to specific identity.

E. antarctica is characteristic of the antarctic and sub-antarctic regions (Fig. 12). According to Ridley (1881) the northernmost find and the type locality was made by the *Alert* expedition in the Trinidad Channel (Madre-de-Dios archipelago in south-west Chili, about 50° S) at only 45 fathoms depth, still the shallowest locality recorded.

The species is remarkably eurybathic. According to present data it is found at depths of some 500 m. (the two deepest Discovery hauls of *E. antarctica* were from St. 1948, 490–610 m., and St. 2200, 532–512 m.). The *Belgica* expedition brought home some specimens of a Stylasterid recorded by von Marenzeller (1903) as *E. gracilis*, which, as stated above, must be regarded as a synonym of *E. antarctica*. Von Marenzeller did not give the exact depths of the four localities south-east of Peter I Island, whereas Hickson (1912) says that the depth 'is probably between 500 and 600 metres'. I am

indebted to the director of Institut Royal des Sciences Naturelles de Belgique, Dr V. van Straelen, for the exact data concerning these localities:

12. v. 1898, 71° 14′ S, 89° 14′ W, depth 450 m.
18. v. 1898, 71° 18′ S, 88° 02′ W, depth 450 m.
27. v. 1898, 71° 15′ S, 87° 39′ W, depth 100 m.
28. v. 1898, 71° 19′ S, 87° 37′ W, depth 435 m.

These data are of great interest combined with the localities from the Discovery collections.

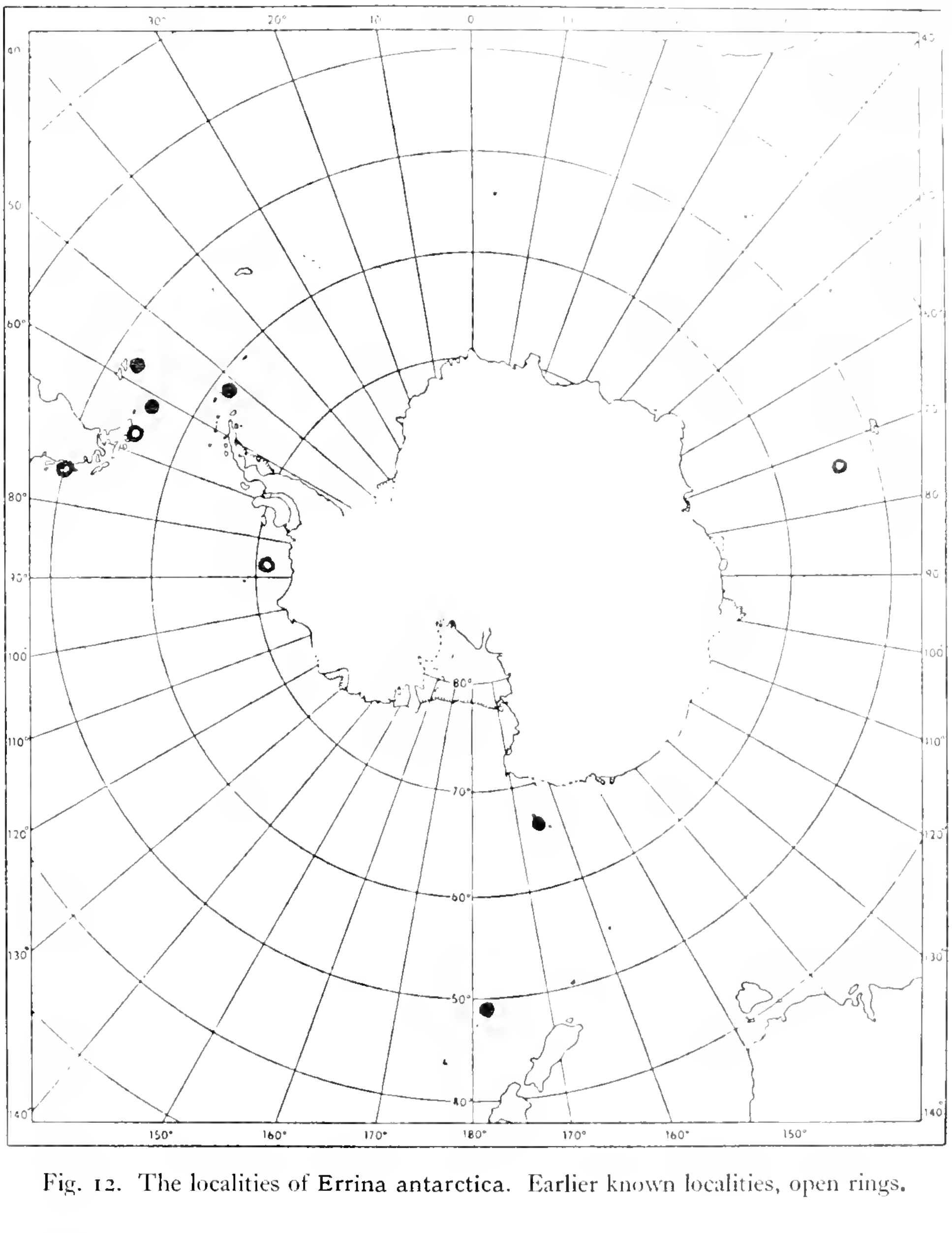


Fig. 12. The localities of **Errina antarctica**. Earlier known localities, open rings.

All localities with depths greater than 400 m. are situated south of the Antarctic Convergence; in sub-antarctic waters, on the other hand, the species has as yet only been met with at depths above 200 m. It must be mentioned here that no depth record exists concerning the two older localities, Cape Horn and Heard Island.

A series of new localities has been added by the Discovery Expedition (see Fig. 12). Allowing for the difficulties attendant on taking Stylasterids in the catches because of their special ecological demands,

we can infer from the chart that the species probably has circumpolar distribution. None of the finds is located north of the Sub-tropical Convergence, which probably indicates the extreme limit of the habitat. The data are at present very scanty, and the deductions may appear a little hypothetical. But we can with certainty maintain that *E. antarctica* is a characteristic sub-antarctic and antarctic species, probably also cicumpolar.

According to data from the Norwegian *Brattegg* expedition in 1947–8, *E. antarctica* is comparatively common on the Burdwood Bank. The Burdwood Bank is also the home of another species of the genus, *E. spongiosa* Broch (1942), which was found by the Swedish Antarctic Expedition 1900–1 at a depth of 137–150 m. No other locality having been discovered as yet, the zoogeographical character of the species is somewhat uncertain; presumably, however, the species is endemic.

A third species of the genus, *E. moseleyi* Ridley (1881), at all events borders on the sub-antarctic region. It was also found by the *Alert* Expedition in the Madre-de-Dios Archipelago, but only in shallow water between 2 and 10 fathoms. Further details concerning this species are wanting.

Zoogeographically the Burdwood Bank and the Falkland Islands belong to the same sub-region as the southernmost coastal waters of South America. Besides the two *Errina* species, *Errinopsis reticulum* also appears to have its home in these waters, and it is therefore reasonable to maintain that according to our present data *Errina antarctica*, *E. spongiosa* and *Errinopsis reticulum* are endemic species of the sub-antarctic (antiboreal) regions. *Errina antarctica* also penetrates into the high-antarctic region and appears to be as numerous here as in the sub-antarctic region.

The collections also contain one representative of the sub-family Stylasteriinae, viz. *Conopora pauciseptata*, from St. 2493, position 42° 03·9′ S, 00° 03·5′ E, south of the Sub-tropical Convergence. The genus *Conopora* has previously only been found in the Indian and Pacific Oceans (Broch, 1942, p. 67, fig. 21), but must now also be added to the Atlantic fauna.

C. pauciseptata is recorded from parts of the oceans, where the bottom fauna has only been scantily explored in spite of its special interest. In benthic regions it is a problem where to draw the limit between sub-antarctic (anti-boreal) and sub-tropical areas, not only in South African and New Zealand waters but also along the coasts of South America, where the coastal shallow-water fauna has also been too insufficiently explored to allow of well-founded zoogeographical deductions. The locality at which *Conopora* was found indicates that it may be an inhabitant of the sub-tropical benthic regions.

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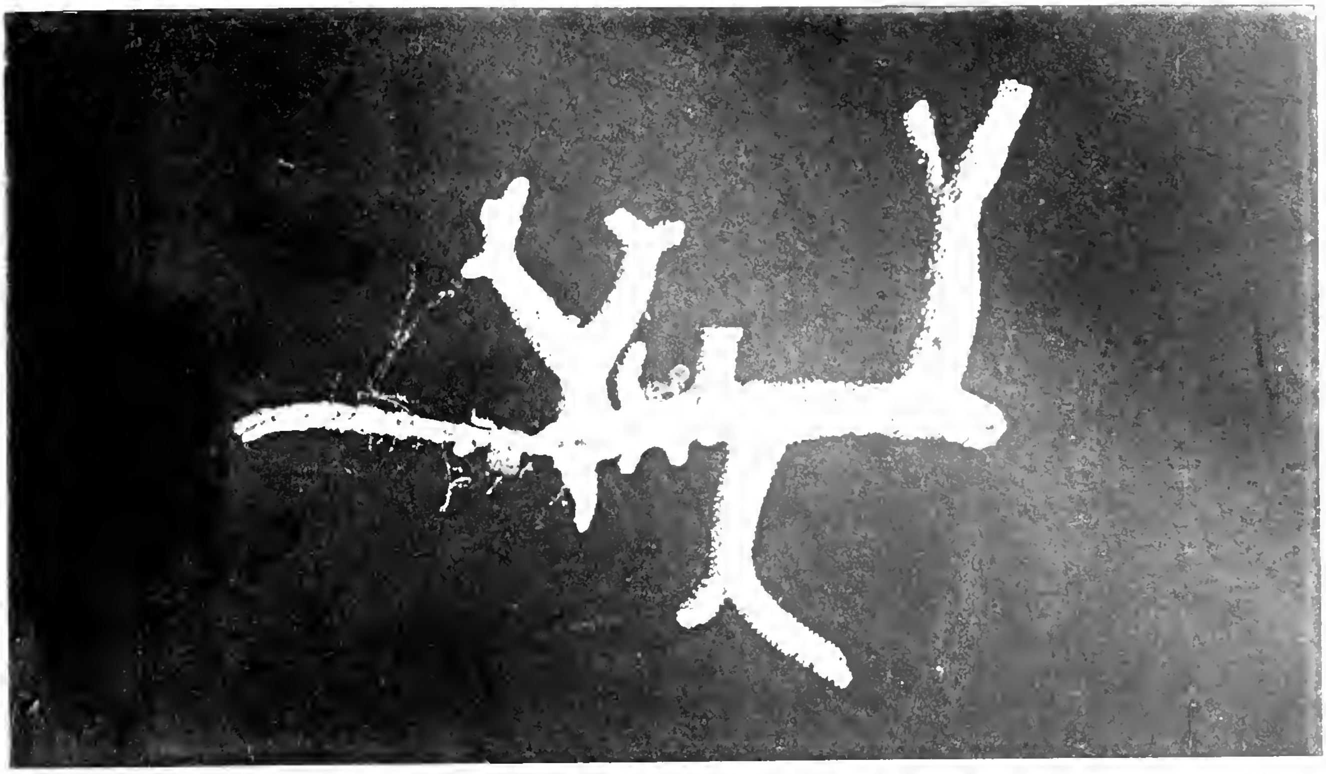
PLATE II

Fig. 1. **Errina antarctica** from St. 652, Burdwood Bank. Stout growth type. Nat. size.

Fig. 2. **Errinopsis reticulum**, ♂, type specimen from St. WS 246, south of Falkland Islands. Nat. size.



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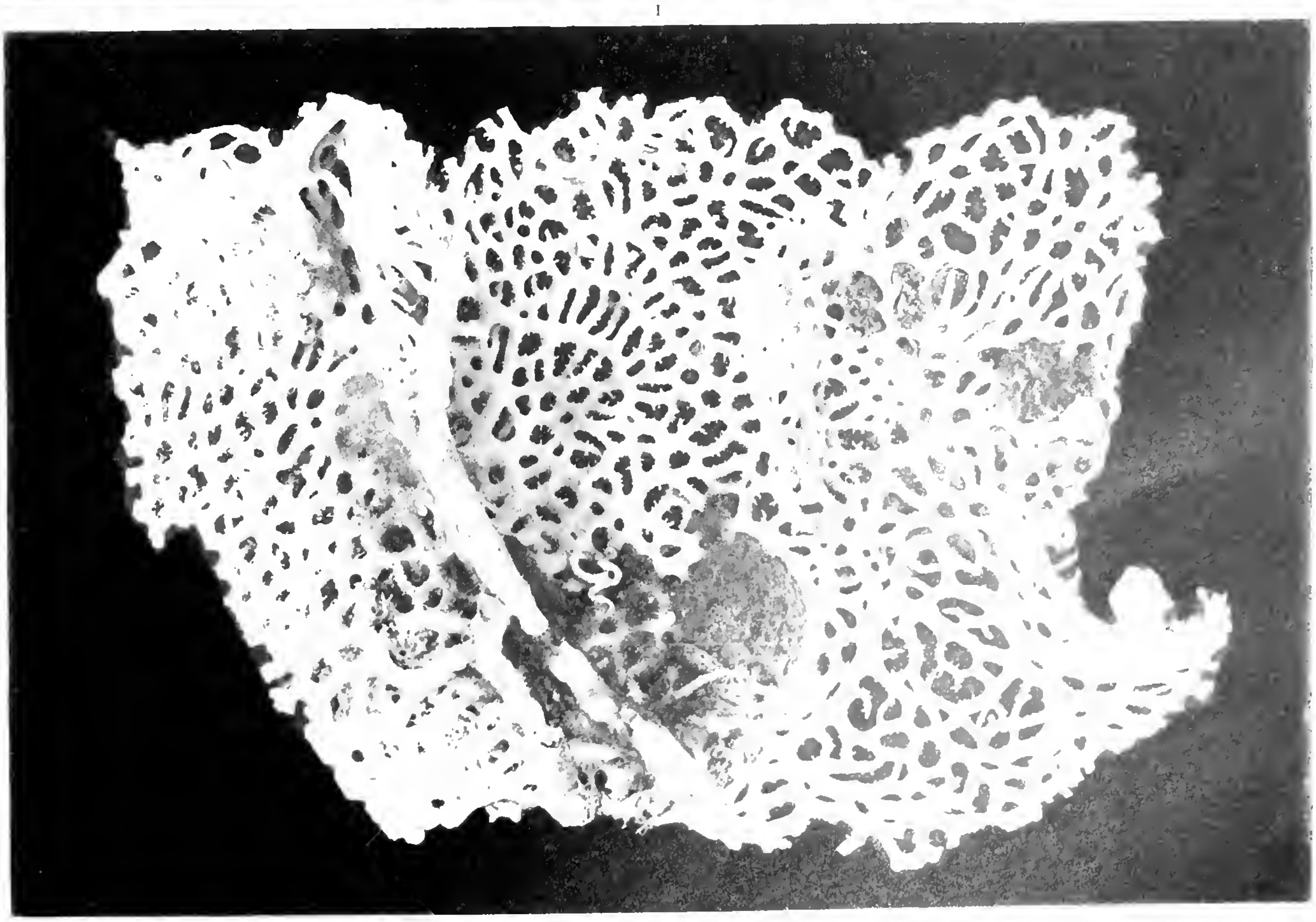

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PLATE III

Fig. 1. **Errinopsis reticulum**, ♀, type specimen from St. WS. 246, south of Falkland Islands. Nat. size.

Fig. 2. **Errinopsis reticulum**, ♀, part of a branch showing surface structure. × 20.

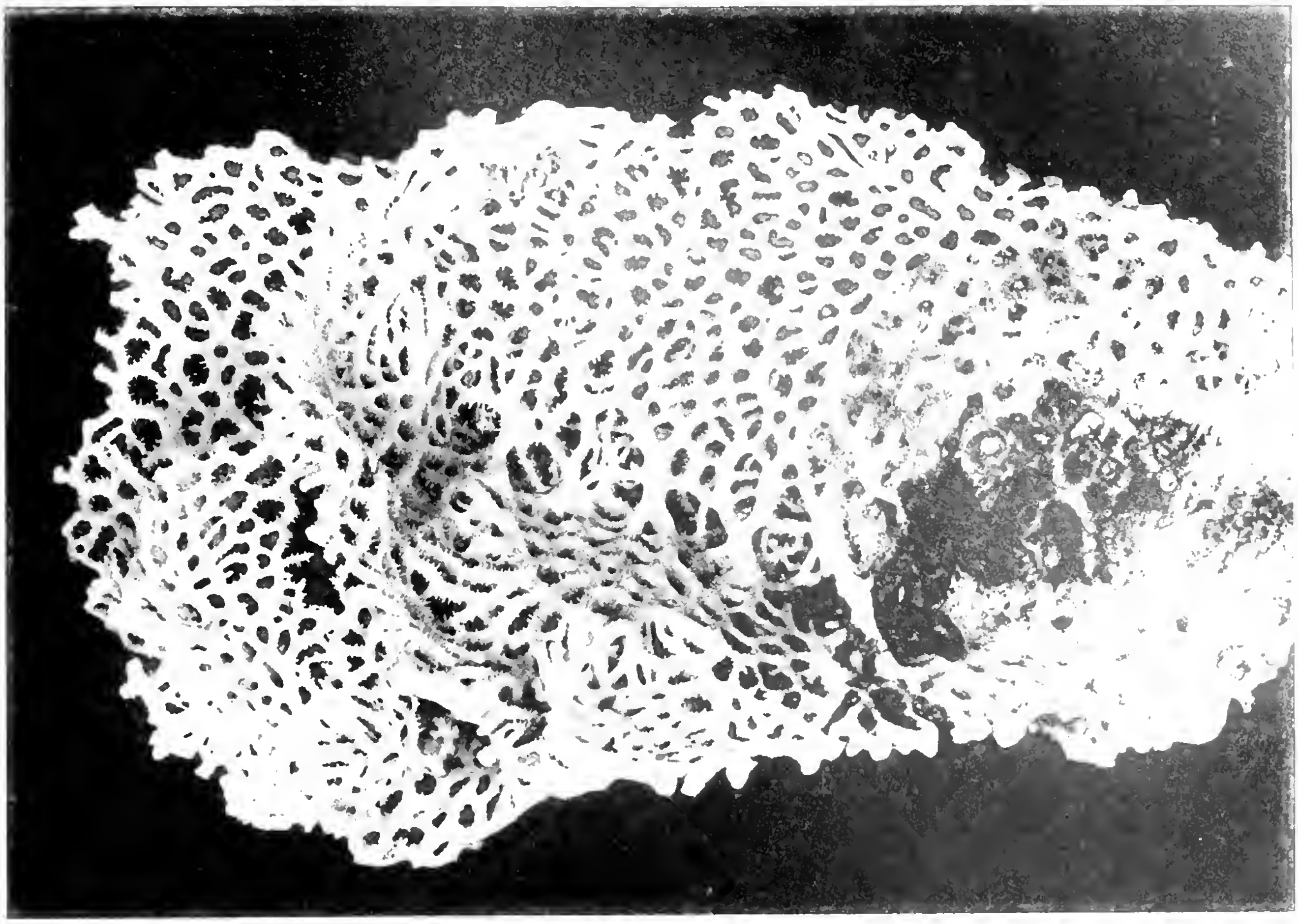

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PLATE IV

Fig. 1. **Conopora pauciseptata.** Type specimen from St. 2493. Anterior side of the fragment. Nat. size.

Fig. 2. **Conopora pauciseptata.** Type specimen from St. 2493. Posterior side of the fragment. Nat. size.

Fig. 3. **Errina antarctica** from St. 2200, Balleny Group. Living colony of the stout type, the median part incrusting the dead stem of an old, dead colony. Nat. size.

Fig. 4. **Errina antarctica** from St. 2200. Fragment of a dead colony of the common, flabelliform type with dichotomic ramification. Nat. size.

Fig. 5. **Errina antarctica** from St. 2200. Fragment of a dead, densely branching colony of the slender type. In spite of the prolific (subdichotomic) ramification and the bushy appearance anastomoses very seldom occur. Nat. size.

Fig. 6. **Errina antarctica** from St. 2200. Basal part of a great dead colony of the common, flabelliform type with subdichotomic ramification. Nat. size.

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O. Bache phot.

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ANTARCTIC AND SUBANTARCTIC MOLLUSCA: PELECYPODA AND GASTROPODA

By

A. W. B. POWELL, F.R.S.N.Z.

CONTENTS

ANTARCTIC AND SUBANTARCTIC MOLLUSCA: PELECYPODA AND GASTROPODA

COLLECTED BY THE SHIPS OF THE DISCOVERY COMMITTEE DURING THE YEARS 1926–1937

By A. W. B. Powell, F.R.S.N.Z.
Auckland Museum

(Plates V–X; Text-figs. A–N)

INTRODUCTION

The material covered by this report is largely from the American Quadrant of the Antarctic and Subantarctic Zones, but with the addition of odd dredgings from Bouvet Island, Marion Island and the Ross Sea. My report covers the Gastropoda (with the exception of the Pteropoda and the Nudibranchiata) and some Pelecypoda. The Pteropoda were reported upon by Anne L. Massy (1932) and the Cephalopoda (in part) by G. C. Robson (1930).

The areas best represented by the Discovery collections are the Falkland Islands and the Patagonian Shelf, South Georgia and the higher latitudes of the Scotia Arc from the South Shetland Islands to the Palmer Archipelago.

The varied nature of these respective areas is ably described by E. Heron-Allen and A. Earland (1932) and A. Earland (1934) in their outstanding work on the Foraminifera. A description of the physical characteristics of each of the biogeographic areas concerned with the present collections follows.

FALKLAND ISLANDS

The Falklands are a group of two large and many small islands lying upon the very extensive East Patagonian Continental Shelf, but almost severed from it by the transverse Falkland Trough which lies at a depth of from 150 to 200 m. between two tongues of deep water which impinge both from the north and the south. The Falklands lie within the Subantarctic Zone of surface waters (isotherms between 6 and 12° C.), and are outside the northern limit of pack-ice. They are strongly influenced by the Cape Horn Current, composed largely of water of Pacific origin, which is swept through Drake Strait by the West Wind Drift and then turns northwards to the Falklands and resolves into the Falkland Current, which continues northward between the Falklands and Patagonia. The West Wind Drift proper passes well to the south of the Falklands. Owing to its position upon the Patagonian Shelf the Falkland marine molluscan fauna is predominantly Magellanic, and the terrestrial fauna, notably the presence of the fresh-water genus *Chilina*, points to a former land link with the Patagonian mainland.

North of the Falklands at the limit of the Continental Shelf, the bottom descends steeply to the Argentine Basin, which comes within the influence of the warm Brazilian Current, which there has a seasonal temperature range of from 11·5 to 14·5° C. (Hart, 1946, p. 243).

Another important factor influencing the Falkland fauna is the presence of the Atlantic-Indian cross-ridge which runs from the Argentine Basin almost to the Kerguelen-Gaussberg (radial) ridge and forms the northern boundary of the Atlantic-Antarctic Basin.

Deep water to the south effectively separates the Falklands from the Burdwood Bank and the rest of the extensive Scotia Arc.

The Falkland molluscan check list which follows is compiled from a number of published papers plus the Discovery Committee's material,* described in this report. The principal contributors to the Falkland fauna were Cooper and Preston (1910), Eliot (1907), Melvill & Standen (1907, 1912, 1914), Preston (1913), Smith (1915) and Strebel (1905–8).

Since the Falkland Islands are situated on the vast East Patagonian Continental Shelf it is not remarkable that the molluscan fauna of these islands is almost wholly Magellanic. A few species appear to be restricted to the Falklands, but their number is bound to be reduced as the Magellanic fauna becomes better known.

The marine molluscan fauna is Subantarctic with a strong admixture of continental temperate extra-limital forms which have been induced to extend far south of their usual station through the continuity of the Patagonian land mass, which has many sheltered inlets, bays and channels.

One species of the characteristic Antarctic genus *Prosipho* occurs, but otherwise Antarctic forms are almost wholly absent.

Characteristic Subantarctic genera which are well represented are *Gaimardia*, *Cyamium*, *Nacella*, *Patinigera*, *Margarella*, *Laevilitorina*, *Parenthria* and *Kerguelenella*.

The following instance temperate forms induced far south of their normal range: *Fissurella* (*Balboaina*), *Calliostoma*, *Polinices*, *Trochita*, *Nassarius*, *Acanthina*, *Typhis*, *Adelomelon* and *Marginella*.

Restricted Magellanic genera are the two Calliostomid derivatives *Photinula* and *Photinastoma*, the Trophonids *Xymenopsis*, *Fuegotrophon* and *Stramonitrophon*, and the Buccinoid genera *Savatieria*, *Anomacme* and *Meteuthria*.

The Atlantic-Indian Ocean cross-ridge has allowed an interchange of several genera and species between the Falklands and the Marion Island-Kerguelen area, notably *Trophon declinans*, *Provocator pulcher*, *Philine kerguelensis* and *Notoficula*. Also the range of two otherwise restricted Magellanic genera, *Glypteuthria* and *Parmaphorella*, has been extended thus to South African waters (Tomlin, 1932). This ridge has facilitated also the considerable eastern Subantarctic extension of the 'bipolar' genera *Fusitriton* and *Aforia*.

Falkland Islands Check List

This check list and those for other areas that follow are provisional only, since I have been unable to examine the actual material upon which many identifications were based. Nevertheless, these lists serve to give an approximate indication of the respective faunule for each biogeographic area. In most instances I have brought the nomenclature up to date, but in a few entries of doubtful taxonomic status the original record is cited, with quotation marks.

Species preceded by an asterisk are represented in the Discovery material; (T.) indicates that the type locality for the species is within the faunal area covered by the list, and the authorities following the names refer to the literature cited at the end of this report.

PELECYPODA

Nucula falklandica Preston, 1912 (T.).
N. pisum Sowerby, 1832; Melvill & Standen, 1914.
Yoldia eightsii (Couthouy, 1839) Melvill & Standen, 1914.
Y. woodwardi Hanley, 1860; Melvill & Standen, 1914.
Limopsis hardingii Melvill & Standen, 1914 (T.).
**L. hirtella* Rochebrune & Mabille, 1889.
'*Philobrya* sp.' Melvill & Standen, 1914.
'*Pecten*' *rufiradiatus* Reeve, 1853; Melvill & Standen, 1914.
Mytilus sp. Melvill & Standen, 1907, 1914 as '*edulis*' Linn.

Editor's Note: By no means all of the Discovery molluscan collections have been reported upon.

'*M. bifurcatus* Conrad' Melvill & Standen, 1914.
'*M. ovalis* Lamarck' Melvill & Standen, 1907.
Aulacomya magellanica Lamarck, 1819; Melvill & Standen, 1907, 1914.
Hormomya blakeana Melvill & Standen, 1914 (T.).
Anomia sp. Melvill & Standen, 1914 as '*ephippium*' Linn.
Gaimardia bennetti Preston, 1913 (T.).
G. exilis (H. & A. Adams, 1853); Melvill & Standen, 1914.
G. gemma (Cooper & Preston, 1910) (T.).
G. mesembrina Melvill & Standen, 1907 (T.) (= *G. picturata* Cooper & Preston, 1910) (T.).
G. trapesina (Lamarck, 1822); Melvill & Standen, 1914.
Cyamium antarcticum Philippi, 1845; Melvill & Standen, 1907.
C. bennetti Preston, 1912 (T.).
C. copiosum Preston, 1913 (T.).
C. cuneatum Preston, 1913 (T.).
C. exasperatum Preston, 1912 (T.).
C. falklandicum Melvill & Standen, 1898 (T.); Melvill & Standen, 1907, 1912, 1914.
C. iridescens Cooper & Preston, 1910 (T.).
C. piscium Preston, 1912 (T.).
C. stanleyense Preston, 1913 (T.).
Cyamionema decoratum Melvill & Standen, 1914 (T.).
Astarte longirostra d'Orbigny (T.).
Carditella naviformis Reeve, 1843; Melvill & Standen, 1914.
Lasaea consanguinea Smith, 1879; Melvill & Standen, 1907, 1914.
Lasaea sp. Melvill & Standen, 1914 as '*miliaris*' Philippi.
'*Kellia cycladiformis* Deshayes, 1851'; Melvill & Standen, 1907 1912, 1914.
Davisia bennetti Preston, 1912 (T.).
D. cobbi Cooper & Preston, 1910 (T.); Melvill & Standen 1914.
D. concentrica Preston, 1912 (T.).
Malvinasia arthuri Cooper & Preston, 1910 (T.).
?*Scacchia plenilunium* Melvill & Standen, 1907 (T.).
Thyasira falklandicus (Smith, 1885); Melvill & Standen, 1907, 1914.
Gomphina (*Acolus*) *foveolata* (Cooper & Preston, 1910) (T.); Melvill & Standen, 1914.
Samarangia exalbida Chemnitz, 1788; Melvill & Standen, 1907.
Darina solenoides King & Broderip, 1830–31; Melvill & Standen, 1914.
Cardium delicatulum Smith, 1915 (T.).
Lyonsia cuneata Gray, Melvill & Standen, 1907, 1914.
Mytilimeria falklandica Preston, 1913 (T.).
Laternula elliptica (King & Broderip, 1832) (= *Thracia antarctica* Melvill & Standen, 1898 (T.) = *Mya antarctica* Melvill & Standen, 1914 (T.)).
Solen macha Molina, 1789; Melvill & Standen, 1914.
Hiatella antarctica (Philippi, 1845); Melvill & Standen, 1914; Preston, 1913 as *Saxicava subantarctica* Preston.
Bankia odhneri Roch, 1931 (T.).
Cuspidaria (*Cardiomya*) *simillima* Smith, 1915.

GASTROPODA

**Patelloida ceciliana* (Orbigny, 1841) (T.); Melvill & Standen, 1907, 1914.
P. ceciliana magellanica (Strebel, 1907); Strebel, 1908; Melvill & Standen, 1914.
'*Acmaea inquilinus* Preston, 1913' (T.).
'*A. perconica* Preston, 1913' (T.).
Scurria scurra (Lesson, 1830); Melvill & Standen, 1914; Preston, 1913 as var. *charon* Preston.
'*Nacella falklandica* Preston, 1913' (T.).
N. mytilina (Helbling, 1779); Melvill & Standen, 1914.
**Patinigera aenea* (Martyn, 1784); Melvill & Standen as '*deaurata* Gmel.', 1907, 1914.

'*P. bennetti* (Preston, 1913)' (T.) (*Helcioniscus*) = ?*aenea*.
**P. delicatissima* (Strebel, 1907); Strebel, 1908; Melvill & Standen, 1914.
P. fuegiensis (Reeve, 1855); Melvill & Standen, 1907.
**Lepeta coppingeri* (Smith, 1881); Strebel, 1908.
**Fissurella* (*Balboaina*) *oriens* Sowerby, 1834; Melvill & Stand, 1907 as var. *mexicana* Sowb.; Strebel, 1908.
**F.* (*Balboaina*) *picta* (Gmelin, 1791); Melvill & Standen, 1907, 1914.
'*F. exquisita* Reeve', Strebel, 1908.
'*F. radiosa* (Lesson, 1826)'; Melvill & Standen, 1914 + *polygona* Sowerby.
**Megatebennus patagonicus* Strebel, 1907; Strebel, 1908; Melvill & Standen, 1914.
**Puncturella conica* (d'Orbigny, 1841) (T.); Strebel, 1908 as *noachina*.
**Parmaphorella melvilli* (Thiele, 1912).
**Calliostoma falklandicum* Strebel, 1908 (T.).
**C. modestulum* Strebel, 1908 (T.); Melvill & Standen, 1912.
C. venustulum Strebel, 1908 (T.).
**Falsimargarita iris* (Smith, 1915) (T.).
**Photinula coerulescens* (King & Broderip, 1830–31); Strebel, 1908; Melvill & Standen, 1914.
**Photinastoma taeniata* (Wood, 1828) (T.); Melvill & Standen, 1907, 1914; Strebel, 1908.
**P. taeniata nivea* (Cooper & Preston, 1910) (T.).
**Margarella expansa* (Sowerby, 1838) (T.); Strebel, 1908; Melvill & Standen, 1907.
**M. violacea* (King & Broderip, 1830–31); Melvill & Standen, 1907, 1914.
'*M. solidula* (Cooper & Preston, 1910)' (T.) (*Photinula*).
'*M. solidula depressa* (Preston, 1913)' (T.) (*Photinula*).
**Solariella kempi* n.sp. (T.).
**Brookula calypso* (Melvill & Standen, 1912).
Laevilitorina bennetti Preston, 1912 (T.).
L. caliginosa (Gould, 1849); Melvill & Standen, 1907, 1914.
L. caliginosa aestualis Strebel, 1908 (T.).
L. latior Preston, 1912 (T.).
Subonoba grisea Martens, 1885; Strebel, 1908.
'*Rissoa inornata* Strebel, 1908' (T.).
Ovirissoa georgiana (Pfeffer, 1886); Strebel, 1908.
Eatoniella kerguelenensis contusa Strebel, 1908 (T.).
**Ataxocerithium pullum* (Philippi, 1845); Melvill & Standen, 1907, 1914; Strebel, 1908.
**Colpospirella algida* (Melvill & Standen, 1912).
**Mathilda malvinarum* Melvill & Standen, 1907 (T.); Strebel, 1908; Melvill & Standen, 1912.
Odostomia biplicata Strebel, 1908; Melvill & Standen, 1914.
Diacolax cucumariae Barth, 1946 (T.).
**Cirsotrema magellanica* (Philippi, 1845); Strebel, 1908.
**C. magellanica latecostata* (Strebel, 1905).
**Acirsa annectens* n.sp. (T.).
Amauropsis anderssoni Strebel, 1907 (T.).
Falsilunatia falklandica (Preston, 1913) (T.).
**F. recognita* (Rochebrune & Mabille, 1889).
**F. soluta* (Gould, 1848); Strebel, 1908.
Polinices patagonicus (Philippi, 1845); Strebel, 1908.
P. subantarcticus (Preston, 1913) (T.).
**Sinuber sculpta* (Martens, 1878) '*Form A*'.
**Tectonatica impervia* (Philippi, 1845); Melvill & Standen, 1914.
Lamellaria ampla Strebel, 1906; Melvill & Standen, 1914.
**L. elata* Strebel, 1907.
**L. patagonica* Smith, 1881.
**Lamellaria* sp.A.
Crepipatella dilatata (Lamarck, 1822); Melvill & Standen, 1907, 1914; Strebel, 1908 as var. *pallida*.

**Trochita clypeolum* (Reeve, 1859).
**T. trochiformis* (Gmelin, 1791) (T. ?); Strebel, 1908; Melvill & Standen, 1914.
**Fusitriton cancellatum* (Lamarck, 1822).
Pareuthria cerealis (Rochebrune & Mabille, 1889); Melvill & Standen, 1914.
**P. fuscata* (Bruguière, 1792) (T. ?); Melvill & Standen, 1907, 1914; Strebel, 1908; Preston, 1913 as *curta* Preston
P. janseni (Strebel, 1905); Strebel, 1908.
**P. magellanica* (Philippi, 1848); Melvill & Standen, 1907, 1914.
**P. michaelseni* (Strebel, 1905); Melvill & Standen, 1907, 1914.
P. mulachi (Strebel, 1905); Melvill & Standen, 1914.
P. plumbea (Philippi, 1844); Melvill & Standen, 1914.
**P. ringei* (Strebel, 1905).
**P. rosea* (Hombron & Jacquinot, 1854); Strebel, 1908.
**P. scalaris* (Watson, 1882).
**Tromina bella* n.sp.
**T. fenestrata* n.sp.
**T. simplex* n.sp.
**Notoficula problematica* n.sp.
Glypteuthria acuminata Smith, 1915 (T.).
G. kobelti (Strebel, 1905); Melvill & Standen, 1914.
G. meridionalis (Smith, 1881); Melvill & Standen, 1914.
Anomacme smithi Strebel, 1905; Melvill & Standen, 1914.
Prosipho crassicostatus (Melvill & Standen, 1907); Melvill & Standen, 1914.
Savatieria areolata (Strebel, 1905); Melvill & Standen, 1914.
S. bertrandi Melvill & Standen, 1914 (T.).
S. molinae Strebel, 1905; Strebel, 1908.
Nassarius vallentini Melvill & Standen, 1907 (T.).
**Trophon declinans* Watson, 1882.
**T. geversianus* (Pallas, 1769); Melvill & Standen, 1907, 1914; Strebel, 1908.
T. malvinarum Strebel, 1908 (T.).
**T. ohlini* Strebel, 1904.
T. pelseneeri Smith, 1915 (T.).
T. philippianus Dunker, 1878; Melvill & Standen, 1907.
**T.* (*Stramonitrophon*) *laciniatus* (Martyn, 1789); Melvill & Standen, 1914.
T. (*Fuegotrophon*) *pallidus* (Broderip, 1833) (T.); (=*crispus* Gould) Melvill & Standen, 1907, 1914; Strebel, 1908.
**Xymenopsis albidus* (Philippi, 1846).
X. brucei (Strebel, 1904); Melvill & Standen, 1907.
X. couthouyi (Strebel, 1904); Strebel, 1908; Melvill & Standen, 1914.
X. decolor (Philippi, 1845); Strebel, 1908.
X. elegans (Strebel, 1904).
X. elongatus (Strebel, 1904); Strebel, 1908.
**X. falklandicus* (Strebel, 1908) (T.).
X. hoylei (Strebel, 1904); Melvill & Standen, 1907.
X. liratus (Gould, 1849); Melvill & Standen, 1907, 1914; Strebel, 1908.
X. ornatus (Strebel, 1904).
X. standeni (Strebel, 1904).
Acanthina calcar (Martyn, 1789); Melvill & Standen, 1914; Strebel, 1908.
Typhina belcheri (Broderip, 1832); (Smith, 1915).
**Admete magellanica* Strebel, 1905; Melvill & Standen, 1907, 1914.
**Adelomelon ancilla* (Solander, 1786); Melvill & Standen, 1907, 1914.
A. becki (Broderip, 1836).
A. ferussacii (Donovan, 1824).
**A. mangeri* (Preston, 1901) (T.).
A. martensi Strebel, 1906.

A. tuberculata (Swainson, 1822).
**Miomelon scoresbyana* n.sp.
**Provocator pulcher* Watson, 1882.
**Marginella warrenii* Marrat, 1876 (T., *hahni*).
**Belalora thielei* n.sp.
'*Bela*' *fulvicans* Strebel, 1908; Melvill & Standen, 1914.
'*B.*' *michaelseni* Strebel, 1905; Strebel, 1908.
**Pleurotomella anomalapex* n.sp. (T.)
**P.? ohlini* (Strebel, 1905).
**Aforia goniodes* (Watson, 1881).
**Leucosyrinx falklandica* n.sp.
**Eumetadrillia fuegiensis* Smith, 1888.
'*Aeolidia serotina* Bergh, 1874'; Eliot, 1907.
'*Cratena valentini* Eliot, 1907'.
Eubranchus falklandica (Eliot, 1907) '*Galvina*'.
'*Coryphella falklandica* Eliot, 1907'.
Necromantes challengeriana ((Bergh) Eliot, 1907) '*Tritonia*'.
'*Diaulula vestita* (Abraham, 1877)'; Eliot, 1907.
'*Staurodoris falklandica* Eliot, 1907'.
'*Acanthodoris falklandica* Eliot, 1907'.
**Acteon bullatus* (Gould, 1847).
**Toledonia perplexa* Dall, 1902.
**Philine falklandica* n.sp. (T.).
**P. kerguelensis* Thiele, 1925.
**Parvaplustrum tenerum* n.sp. (T.).
**Diaphana paessleri* (Strebel, 1905); Strebel, 1908.
Kerguelenella lateralis (Gould, 1846); Melvill & Standen, 1907, 1914.
Pachysiphonaria lessoni (Blainville, 1824); Melvill & Standen, 1914.
'*P. tristensis* (Leach, 1824)'; Strebel, 1908; Falkland Is. records unreliable according to Hubendick, 1946.

AMPHINEURA

Tonicia atrata (Sowerby, 1840); Melvill & Standen, 1907, 1914.
'*T. bennetti* Iredale, ms.' Melvill & Standen, 1914.
Icoplax punicea (Gould, 1846); Melvill & Standen 1907, 1914 as '*illuminatus*'.
Plaxiphora aurata (Spalowsky, 1795); Melvill & Standen, 1914 as '*carmichaelis*'.

CEPHALOPODA

Benthoctopus magellanicus Robson, 1930 (T.).
Octopus rugosus (Bosc, 1792); Robson, 1930.
O. tehuelchus d'Orbigny, 1835; Hoyle, 1912.

The following records are rejected:

(1) '*Anadara chemnitzi* Philippi', Smith, 1915.
(3) '*Cardium edule* Linn.', Melvill & Standen, 1914.
(2) '*Cryptogramma subimbricata* Sowerby', Melvill & Standen, 1914.
(3) '*Lacuna divaricata* Fabricius', Melvill & Standen, 1907.
(3) '*Mangilia costata* Donovan', Melvill & Standen, 1907.
(3) '*Retusa truncatula* Bruguière', Melvill & Standen, 1907.
(3) '*Rissoa parva*' Melvill & Standen, 1907.
(3) '*R.* (*Manzonia*) *zetlandica* Montagu', Melvill & Standen, 1907.
(3) '*Tellina squalida* Pulteney', Melvill & Standen, 1914.

(1) Probable error in Station number; off Rio de Janeiro most likely. (2) Central American species, probably from ship's ballast. (3) Common English species either accidentally introduced through shipping or from ballast.

BURDWOOD BANK

This is a large shoal of from 80 to 150 m. in depth situated south of the Falklands and separated from them by deep water, 500–2000 m. The shoal lies east of Tierra del Fuego, and it is now generally accepted that the line of folding represented by the Andes and their former continuity in what is now termed the Scotia Arc passed through the Burdwood Bank and not the Falkland Islands. A trough of moderately deep water, 250–500 m. severs the bank from Tierra del Fuego, and the ridge connecting it to the eastward with Shag Rocks and South Georgia varies between 1000 and 2000 m., severed in several places by deeper water of between 3000 and 4000 m. (Herdman, 1932, pp. 205–36).

From his studies on fossil Foraminifera dredged from the Burdwood Bank, Macfadyen (1933) states on p. 16 in summarizing these fossil occurrences that the 'beds are clearly shown to be the continuation of those exposed on Tierra del Fuego and Staten Island, and a part of the (renamed) Scotia Arc of folding, which is continued on a trend precisely determined by soundings to lie on the line of the Shag Rocks, South Georgia, Clerke Rocks, South Sandwich Islands, South Orkney Islands to the South Shetlands and Graham Land'.

Only a small molluscan list of fifty-five species is available for this area (Melvill & Standen, 1912, and the Discovery Committee's Collections), but at least thirteen species are apparently restricted to the locality. Of the remainder, fifteen are found in the Falkland Islands, but only three of them, *Davisia cobbi*, *Brookula calypso* and *Colpospirella algida*, are not generally distributed in the Magellanic Province. The bulk of the fauna is Magellanic, but four Antarctic species, *Schizotrochus euglyptus*, *Pellilitorina pellita*, *Balcis antarctica* and *Paradmete fragillima*, here apparently reach their northern limit for the American Quadrant.

Burdwood Bank Check List

PELECYPODA

Hochstetteria sublaevis (Pelseneer, 1903); Melvill & Standen, 1912.
H. wandelensis (Lamy, 1906); Melvill & Standen, 1912.
'*Crenella decussata* Montagu 1808' Melvill & Standen, 1912; probably not this European species.
Cyamium denticulatum Smith, 1907; Melvill & Standen, 1912.
Carditella pallida duodecimcostata Melvill & Standen, 1912 (T.).
Venericardia congelascens Melvill & Standen, 1912 (T.).
Astarte magellanica Smith, 1881; Melvill & Standen, 1912.
'*Diplodonta lamellata* Smith, 1881'; Melvill & Standen, 1912.
Davisia cobbi Cooper & Preston, 1910; Melvill & Standen, 1912.
'*Kellyia cycladiformis* Deshayes, 1855'; Melvill & Standen, 1912.
'*K. magellanica* Smith, 1881'; Melvill & Standen, 1912.

GASTROPODA

Schizotrochus euglyptus (Pelseneer, 1903); Melvill & Standen, 1912.
Scissurella eucharista Melvill & Standen, 1912 (T.).
S. supraplicata Melvill & Standen, 1912 (T.).
Parmaphorella melvilli (Thiele, 1912); Melvill & Standen, 1907 (T.).
Puncturella conica (d'Orbigny, 1841); Melvill & Standen, 1912.
Calliostoma modestulum Strebel, 1908; Melvill & Standen, 1912.
Brookula calypso (Melvill & Standen, 1912) (T.).
Liotella coatsianum (Melvill & Standen, 1912) (T.).
'*Cyclostrema*' *gaudens* Melvill & Standen, 1912 (T.).
Subonoba fuegoensis (Strebel, 1908); Melvill & Standen, 1912.
S. paucilirata (Melvill & Standen, 1912) (T.).
S. sulcata Strebel, 1908; Melvill & Standen, 1912.
S. turqueti (Lamy, 1906); Melvill & Standen, 1912.

'*Homalogyra atomus burdwoodianus* Strebel, 1908' (T).
Pellilitorina pellita (Martens, 1885); Melvill & Standen, 1912.
**Ataxocerithium pullum* (Philippi, 1845); Melvill & Standen, 1912.
'*Bittium*' *burdwoodianum* Melvill & Standen, 1912 (T.).
Cerithiopsis macroura Melvill & Standen, 1912 (T.).
Colpospirella algida (Melvill & Standen, 1912) (T.).
Mathilda rhigomaches Melvill & Standen, 1912 (T.).
Balcis antarctica (Strebel, 1908); Melvill & Standen, 1912.
'*Turbonilla*' *smithi* Strebel, 1905; Melvill & Standen, 1912.
'*T.*' *xenophyes* Melvill & Standen, 1912 (T.).
'*Trichotropis bruceana* Melvill & Standen, 1916' n.nom. for *T. antarctica* Melvill & Standen, 1912, non Thiele, 1912 (T.).
Tectonatica impervia (Philippi, 1845); Melvill & Standen, 1912.
**Trochita trochiformis* (Gmelin, 1791); probably covers '*Calyptraea chinensis*' of Melvill & Standen, 1912.
**T. clypeolum* Reeve, 1859.
Cirsotrema magellanica (Philippi, 1845); Melvill & Standen, 1912.
Trophon philippianus Dunker, 1878; Melvill & Standen, 1912.
T. (*Fuegotrophon*) *pallidus* (Broderip, 1832); Strebel, 1908 as *crispus burdwoodianum* (T.).
Xymenopsis falklandicus Strebel, 1908; Melvill & Standen, 1912.
Antistreptus magellanicus Dall, 1902; Melvill & Standen 1912.
**Pareuthria ringei* (Strebel, 1905).
P. rosea (Hombron & Jacquinot, 1854); Melvill & Standen, 1912.
Savatieria concinna Melvill & Standen, 1912.
Paradmete fragillima (Watson, 1882); Melvill & Standen, 1912 as *typica* Strebel, 1908.
'*Mitra* (*Volutomitra*) *porcellana* Melvill & Standen, 1912'; probably a *Marginella*.
**Leucosyrinx paragenota* n.sp.
'*Bela anderssoni* Strebel, 1908'; Melvill & Standen, 1912.
'*B. fulvicans* Strebel, 1908'; Melvill & Standen, 1912.
Toledonia limnaeaeformis (Smith, 1879); Melvill & Standen, 1912.
'*Retusa truncatula* (Bruguière)' Melvill & Standen, 1912; probably not this European species.

CEPHALOPODA

Octopus brucei Hoyle, 1912 (T.).
Benthoctopus sp. Robson, 1930.

SOUTH GEORGIA AND SHAG ROCKS

This very distinctive biogeographic unit lies from 12 to 20° east of the Burdwood Bank and is part of the Scotia Arc, although it is surrounded by deep water, 3000 m. As pointed out by Earland (1933, p. 29), South Georgia is located in only slightly higher latitudes (54–55° S.) than the Falklands (51°–52° 30′ S), yet the contrast in both their physical conditions and their respective faunas is profound.

The Falklands are situated on the Patagonian Shelf, not the Scotia Arc, and the surrounding waters are ice-free, being out of the influence of the cold West Wind Drift. South Georgia, on the other hand, is an isolated area in a region of deep water, entirely within the influence of the cold West Wind Drift and even land conditions are glacial. Partially resolving upon these conditions the bottom sediments are mainly tenacious blue muds in contrast to the sandy deposits of the Falkland area and the coarse sandy and often volcanic debris of the South Sandwich—South Shetland section of the Scotia Arc. Owing to the far southward extension of the South American land mass the Antarctic Convergence is forced below its average latitude, with the result that the Falklands lie in the Subantarctic and South Georgia, since it is well to the eastward, comes within the Antarctic zone of surface waters.

Regarding the Foraminifera, Earland (1934, p. 8) remarked that 'In its isolation, South Georgia has either preserved or developed species which are almost confined to the island'.

The molluscan fauna has scarcely any species common to the Falklands. On the other hand, the present collections include a number of genera and species previously considered characteristic of the Kerguelen and the Ross Sea areas. Their significance, however, is partly ecological, in that the blue muds of South Georgia are more comparable with the Ross Sea bottom than they are with the coarse sandy bottom of the shallower areas of much of the Scotia Arc. This would account for the presence in South Georgia of the antarctic species *Trichoconcha mirabilis*, but its apparent absence from other Scotia Sea localities.

A physical factor which must have the effect of distributing Ross and Victorian Quadrant species eastward into the Weddell Quadrant is the East Wind Drift which operates contrary to the West Wind Drift at and below 65° S.

The South Georgian fauna must now be fairly completely known. It is very distinctive, and as already noted has little in common with that of the Falklands, which are almost of the same latitude.

There are several endemic genera; *Venustatrochus*, *Promargarita*, *Pfefferia*, *Chlanidotella* and *Cavineptunea*. Antarctic genera and species are strongly represented: *Patinigera polaris*, *Laevilacunaria*, *Trichoconcha*, *Prosipho*, *Chlanidota*, *Probuccinum* and *Neactaeonina*. The widely distributed Antarctic-Subantarctic genera *Gaimardia* and *Margarella* are represented almost entirely by endemic species.

The characteristic Magellanic genera *Nacella*, *Photinula*, *Photinastoma*, *Xymenella* and *Adelomelon* are not represented. Evidence, however, that the Scotia Arc was formerly a more effective route than at present for the southward spread of the Magellanic fauna is shown by the presence of a *Trochita* (*georgiana* n.sp.) and a derivative of *Calliostoma* (*Venustatrochus georgianus* n.gen. and n.sp.). Deep-water severing of the arc has culminated by isolation in the development of the South Georgian fauna as a distinctive unit.

On the other hand, there is a strong representation of both eastern Subantarctic and Antarctic forms characteristic of the Victoria and Enderby Quadrants: *Pellilitorina setosa*, *Amauropsis* (*Kerguelenatica*) *grisea*, *Perissodonta georgiana*, *Sinuber*, *Falsimohnia*, *Proneptunea*, *Trichoconcha*, *Probuccinum* and *Prosipho hunteri*.

South Georgia Check List

PELECYPODA

- *Nucula minuscula* Pfeffer, 1886 (T.).
- *Lissarca miliaris* (Philippi, 1845); David, 1934.
- *L. rubrofusca* Smith, 1875; Martens & Pfeffer, 1886; David, 1934.
- *Hochstetteria quadrata* (Pfeffer, 1886) (T.).
- *H. ungulata* (Pfeffer, 1886) (T.).
- *Cyamium imitans* Pfeffer, 1886; David, 1934.
- *C. willii* Pfeffer, 1886 (T.) (= *mosthaffi* Pfeffer, David, 1934).
- *Cyamionema decoratum* Melvill & Standen, 1914; David, 1934.
- *Gaimardia faba* (Pfeffer, 1886) (T.).
- *G. nigromarginata* (Pfeffer, 1886) (T.).
- *G. subquadrata* (Pfeffer, 1886) (T.).
- *G. trapesina* (Lamarck, 1822); Martens & Pfeffer, 1886.
- *Kidderia bicolor* (Martens, 1885) (T.); David, 1934.
- *Mysella charcoti* (Lamy, 1906); David, 1934.
- '*Lepton*' *costulatum* Martens, 1885 (T.).
- '*Lyonsia*' *arcaeformis* Martens, 1885 (T.).
- *Hiatella antarctica* (Philippi, 1845); Martens & Pfeffer, 1886; David, 1934.
- *Laternula elliptica* (King & Broderip, 1832); David, 1934.

GASTROPODA

***Schizotrochus euglyptus* (Pelseneer, 1903).
**Patinigera polaris* (Hombron & Jacquinot, 1841) (T.); Strebel, 1908; David, 1934.
**P. polaris concinna* (Strebel, 1908) (T.).
**Puncturella conica* (d'Orbigny, 1841).
**Venustatrochus georgianus* n.sp. (T.).
**Margarella jason* n.sp. (T.).
M. notalis Strebel, 1908 (T.).
**M. steineni* (Strebel, 1905) (T.); Strebel, 1908; David, 1934.
M. subantarctica Strebel, 1908 (T.).
**M.* (*Promargarita*) *achilles* (Strebel, 1908) (T.).
**M.* (*Promargarita*) *tropidophoroides* (Strebel, 1908) (T.); David, 1934.
**M.* (*Promargarita*) *tropidophoroides obsoleta* n.subsp. (T.).
**Submargarita impervia* Strebel, 1908 (T.).
**Tropidomarga biangulata* n.sp. (T.).
Microdiscula subcanaliculata (Smith, 1875); (*Skenea*) Strebel, 1908.
**Brookula pfefferi* n.sp. (T.).
**B. strebeli* n.sp. (T.).
**Leptocollonia thielei* n.sp. (T.).
**Laevilitorina caliginosa* (Gould, 1849); Strebel, 1908; David, 1934.
L. granum Pfeffer, 1886 (T.).
L. pygmaea Pfeffer, 1886 (T.); Strebel, 1908.
L. umbilicata Pfeffer, 1886 (T.).
L. venusta Pfeffer, 1886 (T.).
Laevilacunaria antarctica (Martens, 1885) (T.); Strebel, 1908; David, 1934.
**Pellilitorina pellita* (Martens, 1885) (T.); Strebel, 1908; David, 1934.
**P. setosa* (Smith, 1875) Strebel, 1908; David, 1934.
'*Hydrobia*' *georgiana* Pfeffer, 1886 (T.).
Ovirissoa anderssoni (Strebel, 1908) (T.).
O. insignificans (Strebel, 1908) (T.).
**O. georgiana* (Pfeffer, 1886) (T.); Strebel, 1908.
Subonoba grisea (Martens, 1885) (T.).
**Subonoba* cf. *paucilirata* (Melvill & Standen, 1912).
S. schraderi (Strebel, 1908) (T.).
S. steineni (Strebel, 1908) (T.).
S. sulcata (Strebel, 1908) (T.).
**Eatoniella kerguelenensis major* Strebel, 1908 (T.).
E. kerguelenensis contusa Strebel, 1908.
E. subgoniostoma Strebel, 1908 (T.); David, 1934.
Skenella georgiana Pfeffer, 1886 (T.); Strebel, 1908.
**Cerithiella seymouriana* (Strebel, 1908).
Cerithiopsilla bisculpta (Strebel, 1908) (*Bittium*) (T.).
C. georgiana (Pfeffer, 1886) (*Cerithium*) (T.).
**Colpospirella algida* (Melvill & Standen, 1912) (*Turritella*).
'*Liostomia*' *georgiana* Pfeffer, 1886 (T.).
Odostomia translucens (Strebel, 1908) (T.) (*Volutaxiella*).
Streptocionella singularis Pfeffer, 1886 (T.).
Balcis subantarctica (Strebel, 1908) (T.) (*Volutaxiella*).
**Cirsotrema fenestrata* (Strebel, 1908) (T.).
**Amauropsis anderssoni* (Strebel, 1907); Strebel, 1908.
**A. aureolutea* (Strebel, 1908) (T.).
A. georgianus (Strebel, 1908) (T.).

A. (*Kerguelenatica*) *grisea* (Martens, 1878); Strebel, 1908; David, 1934.
**Polinices patagonicus* (Philippi, 1845).
**Sinuber sculpta scotiana* n.subsp.
**Tectonatica impervia* (Philippi, 1845).
**Marseniopsis pacifica* Bergh, 1886.
**Trochita georgiana* n.sp. (T.).
**Trichoconcha mirabilis* Smith, 1907.
**Perissodonta georgiana* Strebel, 1908 (T.).
**Falsimohnia albozonata* (Watson, 1882); David, 1934.
**Prosipho astrolabiensis* (Strebel, 1908).
**P. chordatus* (Strebel, 1908) (T.).
**P. hunteri* Hedley, 1916.
**P. perversus* n.sp. (T.).
**Chlanidota densesculpta* (Martens, 1885) (T.); Strebel, 1908; David, 1934.
**C. paucispiralis* n.sp. (T.).
Pfefferia chordata Strebel, 1908 (T.).
**P. cingulata* Strebel, 1908 (T.).
**P. elata* Strebel, 1908 (T.).
P. palliata Strebel, 1908 (T.).
**Probuccinum angulatum* n.sp. (T.).
**P. delicatulum* n.sp. (T.).
**Cavineptunea monstrosa* n.sp. (T.).
**Chlanidotella modesta* (Martens, 1885) (T.); Strebel, 1908; David, 1934.
**Proneptunea duplicarinata* n.sp. (T.).
**P. fenestrata* n.sp. (T.).
**Trophon albolabratus* Smith, 1875; Strebel, 1908.
**T. brevispira* Martens, 1885 (T.); Strebel, 1908; David, 1934.
T. cribellum Strebel, 1908 (T.); David, 1934.
**T. cuspidarioides* n.sp. (T.).
T. distantelamellatus Strebel, 1908 (T.).
**T. minutus* Melvill & Standen, 1907.
**T. scotianus* n.sp. (T.).
**T. shackletoni paucilamellatus* n.subsp. (T.).
Paradmete curta Strebel, 1908 (T.).
**P. fragillima* (Watson, 1882) (=*typica* Strebel, 1908, T.).
**P. longicauda* Strebel, 1908 (T.).
**Admete antarctica* Strebel, 1908.
**A. consobrina* n.sp. (T.).
**Belaturricula turrita* (Strebel, 1908) (T.).
**Lorabela notophila* (Strebel, 1908) (T.).
**L. pelseneri* (Strebel, 1908) (T.).
'*Bela*' *anderssoni minor* Strebel, 1908 (T.).
'*Bela*' *fulvicans* Strebel, 1908 (T.).
Pleurotomella bathybia Strebel, 1908 (T.).
**Typhlodaphne purissima* (Strebel, 1908) (T.).
Cleodora sulcata (Pfeffer, 1879); Massy, 1932.
Limacina helicina (Phipps, 1774); Massy, 1932.
L. balea (Moeller, 1841) Massy; 1932.
Clione antarctica Smith, 1902; Massy, 1932.
Spongiobranchaea australis d'Orbigny, 1840; Massy, 1932.
'*Aeolis antarctica* Pfeffer, 1886'.
'*A. georgiana* Pfeffer, 1886'.
'*A. schraderi* Pfeffer, 1886'.

'*Tritonia antarctica* Pfeffer, 1886'.
**Neactaeonina cingulata* (Strebel, 1908) (T.).
**N. edentula* (Watson, 1883).
**Toledonia punctata* Thiele, 1912.
**Philine gibba* Strebel, 1908 (T.).
'*Cylichna*' *cumberlandiana* Strebel, 1908 (T.).
Cylichnina georgiana Strebel, 1908 (T.).
**Kaitoa scaphandroides* n.sp. (T.).
Diaphana anderssoni (Strebel, 1908) (T.).
D. antarctica (Pfeffer, 1886) (T.).
D. inflata (Strebel, 1908) (T.).
D. pfefferi (Strebel, 1908) (T.).
**Kerguelenella lateralis* (Gould, 1846).

AMPHINEURA

Terenochiton kerguelenensis (Haddon, 1886) (= *Leptochiton pagenstecheri* Martens & Pfeffer 1886, T.).
Hemiarthrum setulosum (Dall, 1878) Martens & Pfeffer, 1886; David, 1934.
Icoplax steinenii Pfeffer, 1886 (T.).
Tonicina zschaui (Pfeffer, 1886) David, 1934.

CEPHALOPODA

Graneledone charcoti Joubin, 1905; Robson, 1930.
G. turqueti Joubin, 1905; Robson, 1930.
G. polymorpha Robson, 1930 (T.).
Thaumeledone gunteri Robson, 1930 (T.).

SOUTH SANDWICH ISLANDS AND REMAINDER OF SCOTIA ARC

Earland (1934), on the basis of the distribution of the Foraminifera, has divided this section of the Antarctic into the following faunal areas: (1) Weddell Sea; (2) South Sandwich Islands; (3) South Orkney Islands to Clarence Island on the Continental Shelf and Slope; (4) Scotia Sea from 29° 15′ to 60° W; (5) Drake Strait from 60° W; (6) Bransfield Strait and South Shetland Islands; (7) Palmer Archipelago; (8) Bellingshausen Sea.

The whole area is within Antarctic waters, and most of it is either on the Antarctic Continental Shelf or tied to it through the Scotia Arc, which links with Graham Land.

I have added a number of species to the faunal list of the South Sandwich-Palmer Archipelago section of the Scotia Arc, but even now our knowledge of the molluscs of this area is too scanty to reveal any marked molluscan segregation, so for the present the area mentioned above is treated as one faunal unit.

The molluscan list is made up as follows: South Sandwich Islands, 12 species; South Orkneys, 48 species; South Shetlands, 35 species; Palmer Archipelago, 20 species; with a total of 93 species for the four areas, obviously an incomplete list. Contrary to the foraminiferal evidence, a number of molluscs are found to be common to two or more of Earland's eight areas.

Regarding the above four localities provisionally as a whole, there are three marked influences apart from an apparently endemic faunule: (1) South Georgian, (2) Kerguelen, and (3) eastern Antarctic.

The South Georgian influence is represented by *Tropidomarga biangulata*, *Leptocollonia thielei*, *Pellilitorina pellita*, *Eatoniella kerguelenensis major*, *Amauropsis aureolutea*, *Sinuber sculpta scotiana*, *Prosipho astrolabiensis*, *Trophon minutus*, *T. shackletoni paucilamellatus* and *Neactaeonina cingulata*, although perhaps some of the above-mentioned species would be more correctly regarded as a Weddell influence in the South Georgian fauna.

The Kerguelen influence is shown by *Pellilitorina setosa*, *Amauropsis* (*Kerguelenatica*) *grisea*, *Marseniopsis pacifica*, *Paradmete fragillima* and *Neactaeonina edentula*.

Finally, the eastern Antarctic (Enderby and Victoria Quadrants) influence is provided by *Falsimargarita gemma*, *Antimargarita dulcis*, *Subonoba fraudulenta*, *Balcis solitaria*, *Neobuccinum eatoni*, *Prosipho madigani*, *Acteon antarcticus*, *Philine alata* and *Toledonia major*.

Many of these correlatives are of deep-water occurrence, and in consequence are not restricted by the deep-water breaks in the Scotia Arc. The occurrence of the Magellanic genus *Tromina* may be accounted for in this manner.

It will serve no useful purpose to name the apparently endemic species for this group of islands, since further collecting will probably show many of them to be of wider range than our present knowledge indicates. The ultimately acceptable endemic species will be found amongst those indicated in the respective locality columns by 'T.', which signifies type locality. Localization in *Chlanidota* at least is shown by the occurrence of three species not recorded from elsewhere.

In this list an asterisk, as before, indicates that the species occurs in the Discovery collections, 'L.' refers to Lamy's 1906 paper, 'M. & S.' to Melvill & Standen's 1907 and 1912 papers, 'M.' to Massy (1920), 'R.' to Robson (1930), and 'Th.' to Thiele (1912).

South Sandwich Islands, South Orkneys, South Shetland Islands and Palmer Archipelago Check List

	S. Sand.	S. Ork.	S. Shet.	Palm.
PELECYPODA				
Nucula minuscula Pfeffer, 1886	—	M. & S.	—	—
Yoldia eightsi (Couthouy, 1839)	—	M. & S.	—	—
Y. inaequisculpta Lamy, 1906	—	T.	—	—
Y. woodwardi Hanley, 1860	—	L.	—	—
Lissarca bennetti Preston, 1916	—	—	T.	—
L. miliaris (Philippi, 1845)	—	Th.	—	—
L. notorcadensis Melvill & Standen, 1907	—	T.	—	—
L. rubrofusca Smith, 1879	—	M. & S.	—	—
Limatula deceptionensis Preston, 1916	—	—	T.	—
L. pygmaea (Philippi, 1845)	—	M. & S.	—	—
Hochstetteria meridionalis (Smith, 1885)	—	M. & S.	—	—
H. quadrata (Pfeffer, 1886)	—	M. & S.	—	—
H. wandelensis (Lamy, 1906)	—	M. & S.	—	—
Palliolum pteriola Melvill & Standen, 1907	—	T.	—	—
Thyasira falklandica (Smith, 1885)	—	M. & S.	—	—
Lasaea consanguinea (Smith, 1879)	—	M. & S.	—	—
Mysella flavida (Preston, 1916)	—	—	T.	—
'*Kellia*' *lamyi* Melvill & Standen, 1907	—	M. & S.	—	—
Cyamiomactra laminifera (Lamy, 1906)	—	T.	—	—
Laternula elliptica (King & Broderip, 1832)	—	Th.	Th.	—
GASTROPODA				
**Schizotrochus euglyptus* (Pelseneer, 1903)	—	—	—	*
Scissurella timora Melvill & Standen, 1912	—	T.	—	—
**Puncturella conica* (d'Orbigny, 1841)	—	—	*	—
**Patinigera polaris* (Hombron & Jacquinot, 1841)	—	*	*	*
**Falsimargarita gemma* (Smith, 1915)	—	—	*	—
**Antimargarita dulcis* (Smith, 1907)	—	—	*	—
**Tropidomarga biangulata* Powell n.sp.	—	—	*	—
**Margarella antarctica* (Lamy, 1905)	—	T.*	*	*

	S. Sand.	S. Ork.	S. Shet.	Palm.
*_Leptocollonia thielei_ n.sp.	—	—	—	*
'_Cyclostrema_' _meridionale_ Melvill & Standen, 1912	—	T.	—	—
*_Laevilitorina claviformis_ Preston, 1916	—	—	T.	*
*_L._ (_Corneolitorina_) _coriacea_ (Melvill & Standen, 1907)	—	—	T.*	—
*_Laevilacunaria bransfieldensis_ (Preston, 1916)	—	—	T.*	—
*_L._ (_Pellilacunella_) _bennetti_ (Preston, 1916)	—	—	T.	*
*_Pellilitorina pellita_ (Martens, 1885)	—	*	—	—
P. setosa (Smith, 1875)	—	M. & S.	—	—
Subonoba deserta (Smith, 1907)	—	M. & S.	—	—
*_S. fraudulenta_ (Smith, 1907)	—	*	—	—
Ovirissoa adarensis (Smith, 1902)	—	M. & S.	—	—
O. scotiana (Melvill & Standen, 1907)	—	T.	—	—
'_Rissoa_' _edgariana_ Melvill & Standen, 1907	—	T.	—	—
'_Rissoa_' _filostria_ Melvill & Standen, 1912	—	T.	—	—
Eatoniella kerguelenensis major Strebel, 1908	—	M. & S.	—	—
Cerithiopsilla georgiana (Pfeffer, 1886)	—	M. & S.	—	—
*_Cerithiella astrolabiensis_ (Strebel, 1908)	*	—	—	—
*_Turritellopsis thielei_, n.sp.	—	—	—	T.
*_Balcis antarctica_ (Strebel, 1908)	*	—	—	—
*_Balcis_ cf. _solitaria_ (Smith, 1915)	—	—	—	*
*_Balcis_ cf. _tumidula_ (Thiele, 1912)	—	*	—	—
*_Amauropsis aureolutea_ (Strebel, 1908)	*	—	*	—
A. bransfieldensis (Preston, 1916)	—	—	T.	—
A. godfroyi (Lamy, 1910)	—	—	T.	—
*_A._ (_Kerguelenatica_) _grisea_ (Martens, 1878)	—	—	*	—
*_Sinuber sculpta scotiana_ n.subsp.	—	T.	—	
*_Marseniopsis pacifica_ Bergh, 1886	—	*	—	*
Prolacuna notorcadensis (Melvill & Standen, 1907)	—	T.	—	—
*_Antitrichotropis wandelensis_ (Lamy, 1906)	—	—	*	T.
*_Discotrichoconcha cornea_ n.gen and n.sp.	—	—	—	T.
*_Chlanidota elongata_ (Lamy, 1910)	—	—	T.*	—
C. gaini (Lamy, 1910)	—	—	T.	—
*_C. signeyana_ n.sp.	—	T.	—	—
*_Neobuccinum eatoni_ (Smith, 1875)	*	M. & S.	*	—
*_Tromina tricarinata_ n.sp.	—	—	T.	—
*_Prosipho astrolabiensis_ (Strebel, 1908)	—	—	—	*
*_P. madigani_ Hedley, 1916	—	—	—	*
P. crassicostatus (Melvill & Standen, 1907)	—	T.	—	—
'_Mitra_ (_Volutomitra_) _porcellana_ Melvill & Standen, 1912' (probably a _Marginella_)	—	T.	—	—
*_Trophon echinolamellatus_ n.sp.	—	—	T.	—
T. minutus Melvill & Standen, 1907	—	T.	—	—
*_T. poirieria_ n.sp.	—	—	*	T.
*_T. shackletoni paucilamellatus_, n.subsp.	*	—	—	—
*_Harpovoluta charcoti_ (Lamy, 1910)	—	—	T*	—
*_Paradmete fragillima_ (Watson, 1882)	—	—	—	*
*_P. percarinata_ n.sp.	—	—	T.	—
*_Admete antarctica_ Strebel, 1908	—	—	*	—
*_Leucosyrinx paratenoceras_ n.sp.	—	—	T.	*
*_Aforia magnifica_ (Strebel, 1908)	*	—	*	*
*_Conorbela antarctica_ (Strebel, 1908)	—	—	*	—
*_Acteon antarcticus_ Thiele, 1912	—	—	*	—

	S. Sand.	S. Ork.	S. Shet.	Palm.
**Neactaeonina cingulata* (Strebel, 1908)	—	—	*	—
**N. edentula* (Watson, 1883)	—	—	*	—
**Toledonia major* (Hedley, 1911)	—	—	*	—
**Philine alata* Thiele, 1912	*	*	*	*
'*Retusa*' *antarctica* Melvill & Standen, 1912	—	T.	—	—
Cleodora sulcata (Pfeffer, 1879)	M.	—	—	—
Limacina helicina (Phipps, 1774)	M.	—	—	—
'*L. costulata* Preston, 1916'	—	—	T.	—
L. balea (Moeller, 1841)	M.	—	—	—
Clione antarctica Smith, 1902	M.	—	—	—
Spongiobranchaea australis d'Orbigny, 1840	M.	—	—	—
Notaeolidia gigas Eliot, 1905	—	T.	—	—
N. purpurea Eliot, 1905	—	T.	—	—
Necromantes appendiculata (Eliot, 1905) *Tritonia*	—	T.	—	—
AMPHINEURA				
Terenochiton kerguelenensis (Haddon, 1886) (=*pagenstecheri* Martens & Pfeffer, 1886)	—	M. & S.	—	—
Chaetopleura brucei (Iredale) Melvill & Standen, 1912	—	T.	—	—
Plaxiphora aurata (Spalowsky, 1795)	—	M. & S.	—	—
Hemiarthrum setulosum Dall, 1876	—	M. & S.	—	—
CEPHALOPODA				
Cirroteuthis glacialis Robson, 1930	—	—	—	T
Graneledone turqueti Joubin, 1905	—	—	—	R.

BIPOLARITY

Early workers on the southern high-latitude molluscs noted the general similarity of the fauna to that of the Arctic, but as pointed out by Smith (1902 (*a*), p. 166): 'It is a notorious fact that Mollusca from high latitudes and from deep water are to a great extent devoid of bright colours. Even this prevailing dull appearance of the shells from the Arctic and Antarctic areas is almost enough to suggest an imaginary resemblance.'

Subsequent workers have eliminated many molluscan claims to bipolar distribution either by demonstrating from anatomical researches that quite different animals are concerned, or by revealing the presence of a more or less cosmopolitan distribution for species formerly thought to be restricted to high latitudes. This is especially true in the Pteropoda. Nevertheless, a number of apparently genuine instances of bipolarity remain for consideration.

The term bipolarity has long been in use to indicate the presence of supposedly identical animals in the higher latitudes of both hemispheres and their apparent absence from intervening temperate and tropical waters.

It has been noted that whereas certain stenothermic animals are present at moderate depths only in both polar regions, they achieve continuity over the warm zones by descending to the cold waters of the ocean deeps. The distribution of the molluscan genus *Aforia* is a case in point.

Sverdrup, Johnson & Fleming (1942) define the three hypotheses that have been advanced to explain bipolarity. They are:

(1) 'Bipolar animals are relics of a previous cosmopolitan fauna, the tropical portion of which is now extinct.'

(2) 'Animals have migrated through cold deep water.'

(3) 'Parallel development of the bipolar forms.'

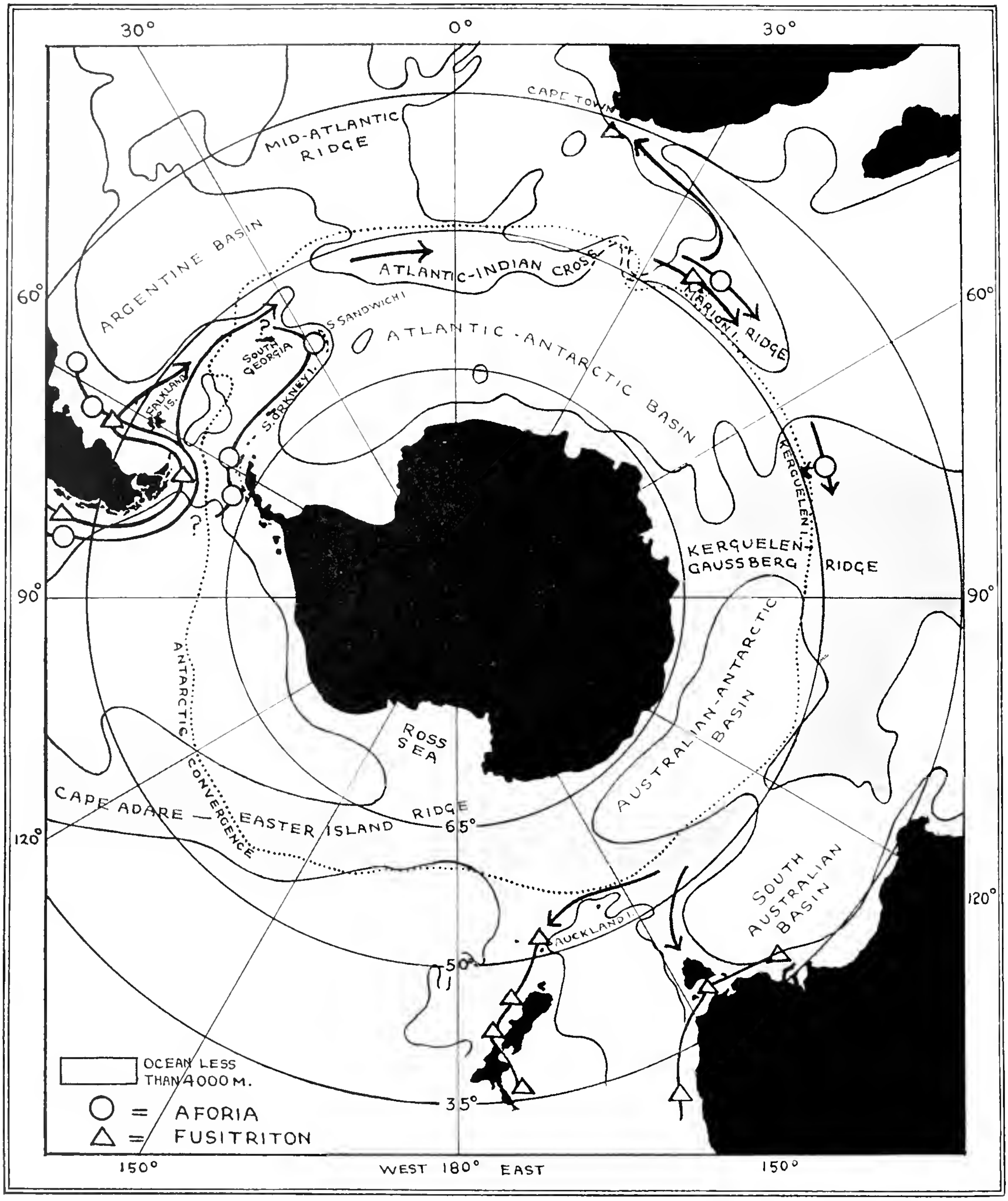

Fig. A. Southern Ocean (Polar Projection), showing distribution of *Aforia* and *Fusitriton*. Tinted areas less than 4000 m. deep. Map adapted from Deacon (1937) and Mackintosh (1946).

It would seem that hypotheses (1) and (2), which are basically the same, adequately explain this apparent phenomenon in general, and that (3) is scarcely justified, since present anomalies in distribution probably result only from incomplete knowledge of past conditions. For instance, did the periods of glaciation in the Pleistocene bring the cold-water faunas of both hemispheres sufficiently close together to allow of a more efficient interchange of species than at present?

In Figs. A and B I have plotted the known ranges of the molluscan genera *Aforia*, *Fusitriton* and *Acanthina*. These genera occur both in northern and southern high latitudes; they are not cosmopolitan, yet they have preserved a connected range that is obviously resultant from the continuity of the western coastline of the Americas plus their southern extension as the Scotia Arc. *Aforia* is stenothermic and has achieved continuity by going deep beneath the surface warm zones, but *Acanthina* is eurythermic and maintains a connected distribution over the shallow warm zones. It is best developed in the central warm-water portion of its range, but has developed a cold-water tolerance also. *Fusitriton* is apparently

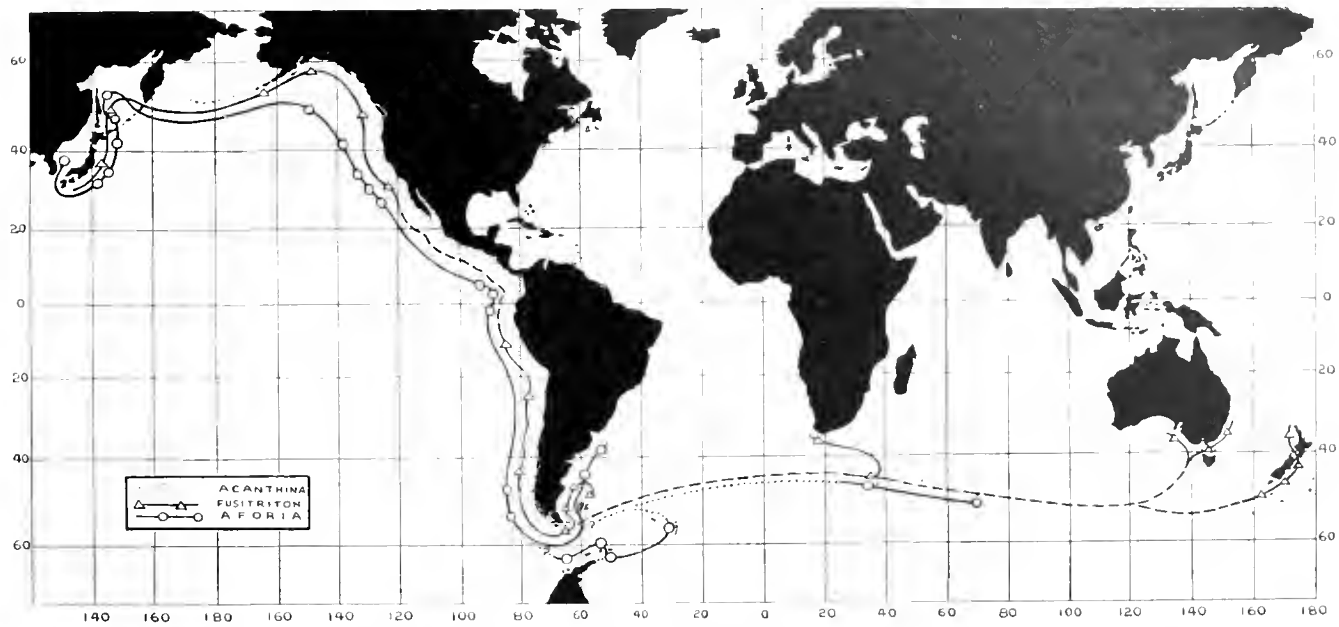

Fig. B. Distribution of *Acanthina* (shallow water) and *Fusitriton* and *Aforia* (continental shelf and deeper).

stenothermic, with a considerable depth range, to as much as 1800 fathoms in one instance, but it is restricted for the most part to the continental shelves. Its almost complete continuity along the western coastline of the Americas is undoubtedly due in some measure to upwelling of cold currents such as the Peru coastal current.

The littoral southern molluscs of the genera *Kerguelenella* and *Pachysiphonaria* have their northern counterpart in *Liriola*, but connecting forms are absent from warm seas, since these stenothermic animals apparently have not adapted themselves to a benthic habitat. The question is, under what former conditions did they achieve a connected range?

Stephen (1941, p. 243), in his report on the *Echiuridae*, *Siphunculidae* and *Priapulidae*, lists twenty-three Antarctic and Subantarctic species, of which ten are identical with and two close to Arctic species. A remark, applicable also to the molluscs, is that 'most of the bipolar species are confined to the South American Quadrant'.

The bulk of the Antarctic and Subantarctic molluscs are derivatives of a few cosmopolitan families: notably the *Patellidae*, *Fissurellidae*, *Trochidae*, *Littorinidae*, *Naticidae*, *Muricidae*, *Neptuniidae*, *Volutidae* and *Turridae*.

The inference is that the present Antarctic fauna is of comparatively recent immigration, probably no earlier than Tertiary times, and that the continuity of the Americas is and has been the chief colonizing route.

Distribution of Aforia

Species and location	Depth in fathom	Temp. °F.	Date
insignis (Jeffreys, 1883), 'Icy Sea', Siberia	—	—	—
okhotskensis Bartsch, 1945, Okhotsk Sea, 50–60° N	73	30·9	—
kincaidi (Dall, 1920), Shelikoff Strait, Alaska	—	—	—
sakhalinensis Bartsch, 1945, off Sakhalin I.	399	38·1	—
diomedea Bartsch, 1945, Hokkaido, Japan	266–399	32·1–38·1	—
chosenensis Bartsch, 1945, Japan Sea, 40° N	122	34·1	—
japonica (Dall, 1925), Honshu, Japan, 35° N	369	41·8	—
hondoana (Dall, 1925), Hondo, Japan	614	37·5	—
crebristriata (Dall, 1908), south-west of Sitka, Alaska	1569	34·9	—
persimilis leonis (Dall, 1908), Washington	877	36·6	—
persimilis blanca (Dall, 1919), Cape Blanco, Oregon	1064	35·9	—
amycus (Dall, 1920), off Monterey, California	871	38	—
persimilis (Dall, 1889), Cortez Bank, California	984	38	—
Gulf of Panama	1020	36·8	10 Mar. 1891
off Panama	1067	37	27 Feb. 1891
off Ecuador, 1° 03′ N	741	38·4	—
south-west coast of Chile	677	38	—
goodei (Dall, 1889), north-west Patagonia, 45° 35′ S	1050	36·9	—
goniodes (Watson, 1881), south-east of Rio de Plata, Argentina	600	37·2	14 Feb. 1876
between Falklands and Patagonia	82	—	30 Mar. 1932
staminea (Watson, 1881), off Marion and Prince Edward Is.	1375	35·6	29 Dec. 1873
Kerguelen I.	105	—	—
magnifica (Strebel, 1908), south-west of Snow Hill I. 64° S	82	—	—
Palmer Archipelago	152–273	32·38	14 Mar. 1927
South Shetlands	214	32·07	11 Jan. 1937
South Sandwich Is.	180	32·7	26 Feb. 1930

The temperatures cited are associated with specimens dredged at various seasons of the year, nevertheless the lowest temperature record, 30·9° F., and the highest, 41·8° F., show a surprisingly small range, with a maximum difference of only 10·9°. That these stenothermic animals go deep over the tropics in order to keep within their temperature requirements is clearly shown by the *persimilis* records, especially that of the Ecuador occurrence, which at a depth of 741 fathoms and a temperature of 38·4° F. is situated only 1° 03′ N of the equator.

BIOGEOGRAPHICAL PROVINCES

It is not desirable at this stage of our knowledge of southern high-latitude molluscs to formulate a comprehensive scheme of biogeographical provinces.

A set of quadrant names proposed by Markham (1912) for the Antarctic and by Waite (1916) for the Subantarctic extensions of these quadrants may be usefully employed for indicating positions and in recording distribution.

The Antarctic quadrants named by Markham were:

The Victoria Quadrant:	90° to 180° E
The Ross Quadrant:	180° to 90° W
The Weddell Quadrant:	90° to 0° W
The Enderby Quadrant:	0° to 90° E.

The Subantarctic extended quadrants proposed by Waite were:

Australian Zonal Quadrant:	An extension of Victoria Quadrant.
Pacific Zonal Quadrant:	An extension of Ross Quadrant.
American Zonal Quadrant:	An extension of Weddell Quadrant.
African Zonal Quadrant:	An extension of Enderby Quadrant.

To these arbitrarily defined areas Waite proposed the following faunal districts:

A. Antipodes District. Subantarctic Islands of New Zealand, including Macquarie Island, Stewart Island, and southern Otago of the South Island of New Zealand.

M. Magellan District.

K. Kerguelen District. Includes Marion Island, Crozets, Heard Island and Kerguelen.

G. Glacial District. The whole of the Antarctic within the Antarctic Convergence.

Finlay (1926, p. 328) proposed five New Zealand faunal provinces, the last two of which, the Forsterian for South and Stewart Islands, New Zealand, and the Rossian for the Subantarctic Islands of New Zealand including Macquarie Island, are relevant to this discussion.

The name Rossian is an unfortunate choice, since it precludes a more appropriate use of this name for the Ross Sea area. In any case I recommend the substitution of Antipodean for Finlay's Rossian, since Waite's earlier propositions were overlooked by Finlay. I also advocate the use of Waite's Magellan and Kerguelen Districts, but consider his fourth one, the Glacial, pointless, since it merely substitutes a term for the restricted Antarctic circumpolar area which will later require subdivision on a faunal basis.

At the present stage I nominate only one addition to the biogeographic areas already outlined, that is, the Georgian for the South Georgia-Shag Rocks area.

Mackintosh (1946, pp. 177–212) gave a detailed account of the Antarctic Convergence with charts. The plotting of the mean position of the Convergence places South Georgia within the Antarctic Zone, Macquarie Island in the Subantarctic Zone, Kerguelen Island right on the convergence, with Heard Island below, and Marion Island-Crozets above it.

The following named southern high-latitude provinces are recommended for the present:

(1) *Magellan*. Patagonia from below Chiloe Island (west coast) and Cape Blanco (east coast) (Regan, 1924, p. 26), Tierra del Fuego, East Patagonian Continental Shelf including the Falkland Islands and the Burdwood Bank.

(2) *Georgian*. South Georgia and Shag Rocks.

(3) *Kerguelenian*. Kerguelen Island plus Heard Island, the Crozets, Marion and Prince Edward Islands. Possibly Bouvet Island.

(4) *Antipodean* (=Rossian). Subantarctic Islands of New Zealand including Macquarie Island.

DISTRIBUTION OF SOUTHERN HIGH-LATITUDE MOLLUSCA

The bulk of the Antarctic and Subantarctic molluscs are derivatives of a few cosmopolitan families, notably the Patellidae, Trochidae, Naticidae, Muricidae, Neptuniidae, Volutidae and Turridae.

Family Patellidae

The limpets belong to two characteristic Magellanic genera, *Patinigera* and *Nacella*. The former ranges from the Magellan Province to Graham Land and eastwards to Kerguelen Island, Macquarie Island and the Subantarctic Islands of New Zealand. True *Nacella* is recorded from the Magellan Province and Kerguelen, but does not seem to occur elsewhere. *Nacella* and *Patinigera*, to some extent, live attached to the giant kelp *D'Urvillea*, and this habit is the main cause, aided by the West Wind Drift, of their eastern extended range.

These genera are stenothermic, for in the New Zealand Subantarctic groups, Campbell and Auckland Islands, the common limpets are of the subtropical genus *Cellana* which occurs to the entire exclusion of *Patinigera* over the rest of the New Zealand area to the north.

Family Fissurellidae

The large Fissurellid subgenus *Balboaina* is restricted to the Magellan Province. The species *Puncturella conica*, which is found in most southern high latitudes, is distinguished only with difficulty from the boreal genotype. It is a good example of a 'bipolar' genus which ranges deep over the warm zones. The route of migration to the south or vice versa could be either the eastern or western American coastlines, or both. *Parmaphorella* occurs in the Magellan Province and extends via the Atlantic-Indian Ocean cross-ridge to South Africa. The related genus *Tugalia* is found in warm water in the East Indian-Australian-New Zealand regions.

Family Trochidae

The Trochoids form a conspicuous element in the Antarctic-Subantarctic region (see Fig. C).

A. *Calliostoma* group. True *Calliostoma* does not extend farther south than the Magellan Province, but the following genera are specialized Antarctic-Subantarctic derivatives of *Calliostoma*:

(1) *Photinula*. Magellan, 0–202 m.

(2) *Photinastoma*. Magellan, 0–115 m.

(3) *Venustatrochus* n.g. South Georgia only, 120–204 m.

(4) *Falsimargarita* n.g. Falkland Islands, South Shetland Islands and off Oates Land, 69° 43′ S, 163° 24′ E, 250–468 m.

B. *Margarella* group. This is a wide-ranging, high-latitude southern genus related to the boreal *Margarita*. Many of its members are directly herbivorous, and its circum-subantarctic range no doubt has been assisted by the direct agency of the West Wind Drift. The genus is common in the Magellan Province, South Georgia to Graham Land, eastward along the Antarctic Continental Shelf to the Ross Sea and via the Atlantic-Indian Ocean cross-ridge to Marion Island, the Crozets, Kerguelen, Macquarie Island, the subantarctic islands of New Zealand, and the southern and eastern coastline of the South Island of New Zealand to about 42° S. The New Zealand members are littoral species mostly restricted to the holdfasts of the giant kelp *D'Urvillea*.

The subgenus *Promargarita* is restricted to South Georgia, and the somewhat related *Submargarita* ranges from South Georgia to Kerguelen and the Davis Sea.

Other *Margarita*-like genera are the elaborately sculptured *Antimargarita* n.g., circum-antarctic in deep water (130–400 fathoms) and *Tropidomarga* n.g., South Georgia and Clarence Island, 160–342 m.

Solariella occurs in deep water from the Falklands to Heard Island and Kerguelen. The genotype is from the English Pliocene, but the genus is well represented in north-west America, the North Atlantic and the Indian Ocean.

From the above it can be assumed that this considerable southern high-latitude radiation of Trochoids originated from the American Quadrant.

Family Littorinidae

The periwinkles are represented by the wide-ranging, mainly subantarctic genus *Laevilitorina*, several specialized genera from the higher latitudes of the Scotia Arc, and *Pellilitorina*, which has been recorded from the Burdwood Bank, South Georgia, South Orkneys, South Shetlands, Bouvet Island, Kerguelen and Cape Adare (Antarctica). A South Australian species, *globula* Angas, 1880, has been referred to *Pellilitorina*, which it certainly resembles, but this claim requires confirmation.

True *Laevilitorina* ranges from Patagonia to the subantarctic islands of New Zealand, but is replaced on the New Zealand mainland by *Zelaxitas*. Here again the Australian '*Laevilitorina*' *mariae* Tennyson Woods, 1876, requires investigation. The distribution of the Laevilitorinids is again suggestive of an eastern subantarctic drift from the American Quadrant.

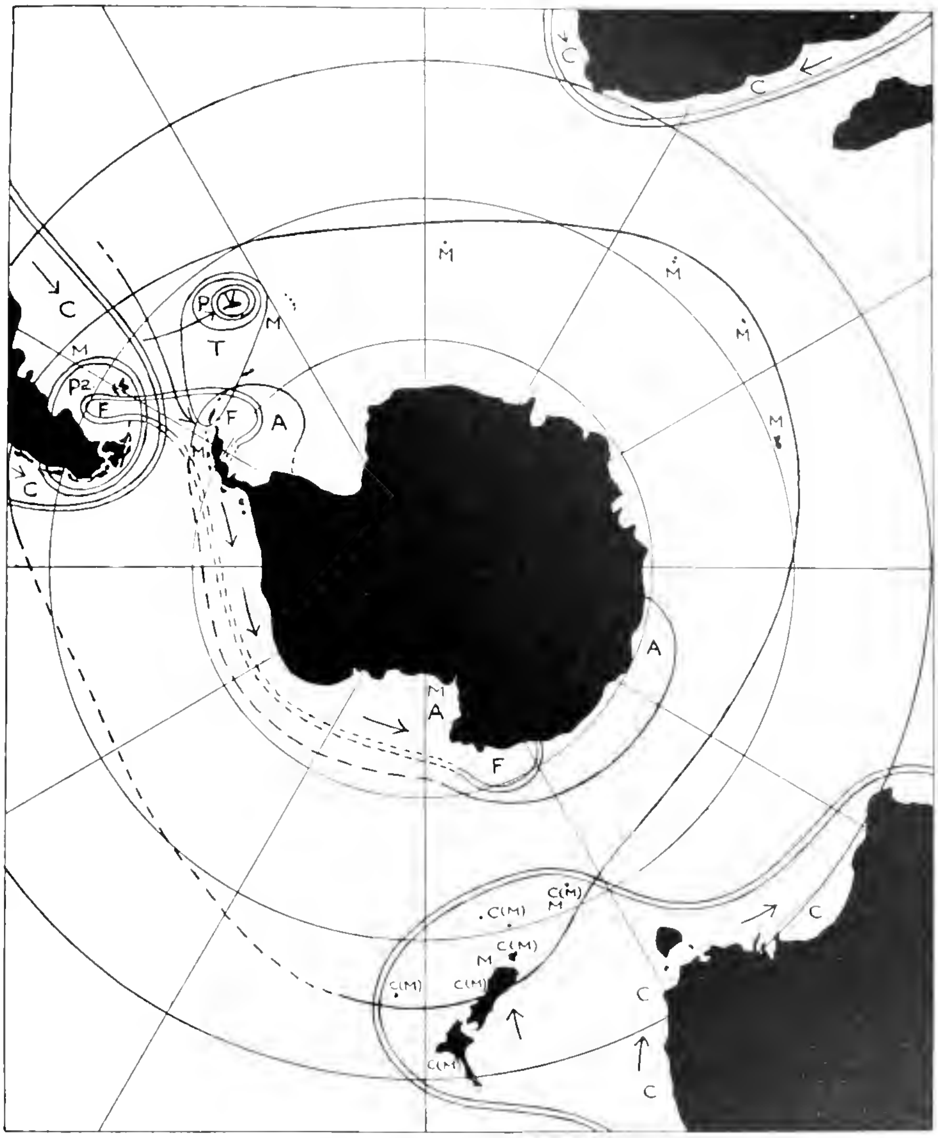

Fig. C. Distribution of Antarctic and Subantarctic Trochoids. Calliostomatinae bounded by double lines, Stomatellinae by a single line. *A* = *Antimargarita*. *C* = *Calliostoma*. *C* (*M*) = *Calliostoma* (*Venustas*). *F* = *Falsimargarita*. *M* = *Margarella*. *P* = *Promargarita*. *P2* = *Photinula* and *Photinastoma*. *T* = *Tropidomarga*. *V* = *Venustatrochus*.

Family Naticidae

If I am correct in assigning most of the southern high-latitude Naticoids to the boreal genus *Amauropsis*, there is no doubt that the continuity of the west coast of the Americas indicates the former route. Of the remaining Naticoid genera, *Falsilunatia* has most in common with northern *Lunatia*, *Tectonatica* is a Mediterranean Pliocene genus, *Sinuber* ranges from the Falkland Islands and South Georgia to the South Shetland Islands and eastwards to Kerguelen and the Ross Sea, and *Prolacuna* is apparently restricted to deep water of Antarctic occurrence, extending from the Davis Sea to the Ross Sea. The American route is again indicated.

Family Trichotropidae

There are four endemic southern high-latitude genera in this family, clearly related to the boreal genera, *Trichotropis* and *Torellia*. The range of the four southern genera is:

(1) *Antitrichotropis*: Antarctic, Palmer Archipelago to Ross Sea.
(2) *Trichoconcha*: Antarctic, South Georgia to Ross Sea.
(3) *Neoconcha*: Ross Sea.
(4) *Discotrichoconcha*: Palmer Archipelago.

Familes Crepidulidae and Calyptraeidae

The genus *Crepipatella* is of West American origin, *dilatata* occurring from the west coast of South America and the Magellan Province, and *lingulata* from the Bering Sea to Panama.

The genus *Trochita* is West American also, ranging from Panama to the Magellan Province and occurring also at South Georgia. The simplification of the septum in the South Georgian species suggests that it and the New Zealand *Zegalerus* may have had a common origin in the south.

Family Struthiolariidae

In the systematic section I suggest that the only living southern high-latitude Struthiolarid genus, *Perissodonta*, is identical with a South American Oligocene group (*Struthiolarella*). The known range of the Struthiolariidae is: Patagonia (Oligocene), South Georgia and Kerguelen Island (Recent), *Perissodonta*; New Zealand, *Conchothyra* (Upper Cretaceous), *Perissodonta* (*Struthiolarella minor* (Marshall, 1917)) (Danian, Upper Cretaceous), *Monalaria* (Lower Tertiary), *Callusaria* (Middle and Upper Tertiary), *Struthiolaria* (Middle Tertiary to Recent), *Pelicaria* (Upper Tertiary to Recent); Southern Australia, *Tylospira*, Upper Tertiary to Recent.

The family seems to have had its origin in the Jurassic to Recent Aporrhaidae, which are of northern hemisphere origin, to have spread down the Americas to Patagonia and finally reached South Georgia, Kerguelen, New Zealand and Australia by shallow-water extensions from Antarctica. The present discontinuous distribution of Struthiolarids is evidently the result of extinctions over much of the probable former range of the family.

Family Cymatiidae

The genus *Fusitriton* has been referred to in the previous section on 'Bipolarity' and is dealt with more fully in the systematic section. Its range is from Japan via the Aleutian Chain, the western coast of the Americas, Falkland Islands, South Africa, Marion Island via the Atlantic-Indian Ocean cross-ridge, New Zealand and southern to eastern Australia.

Family Buccinulidae

The southern whelks are apparently related to the northern Neptuniidae rather than to the northern Buccinidae. There is a considerable radiation of southern generic groups, even more so than in the Trochidae. The distribution of these genera is as follows:

(1) *Pareuthria*. Magellan, Davis Sea and Campbell Island, New Zealand Subantarctic.
(2) *Tromina*. Magellan, and Clarence Island, South Shetlands.
(3) *Notoficula*. Bouvet Island and Falkland Islands. Atlantic-Indian Ocean cross-ridge.
(4) *Falsimohnia* n.g. South Georgia and Kerguelen Island.
(5) *Glypteuthria*. Magellan and South Africa. Atlantic-Indian Ocean cross-ridge.
(6) *Chlanidota*. South Shetlands, South Orkneys, South Georgia, Bouvet Island, Kerguelen Island and Cape Adare.
(7) *Pfefferia*. South Georgia.
(8) *Neobuccinum*. Graham Land to Ross Sea and Kerguelen Island.

(9) *Probuccinum*. South Georgia to Ross Sea, Kerguelen Island and Macquarie Island. North-west Patagonia?
(10) *Cavineptunea* n.g. South Georgia and Shag Rocks.
(11) *Prosipho*. Graham Land to Ross Sea; South Georgia to Kerguelen Island and Macquarie Island.
(12) *Anomacme*. Magellan.
(13) *Meteuthria*. Magellan to Heard and Kerguelen Islands.
(14) *Proneptunea*. Kerguelen Island, South Georgia and Shag Rocks.
(15) *Chlanidotella*. South Georgia.

Family Muricidae

The family is represented by numerous Trophons, the West American genus *Acanthina* in the Magellan Province and the Falkland *Typhina belcheri*, probably of warm-water African origin. Typical *Trophon* ranges from the Magellan Province over the whole circumference of the Antarctic Continental Shelf via the Scotia Arc, as well as to Kerguelen and Macquarie Islands. The new genus *Xymenopsis* and the new subgenera *Fuegotrophon* and *Stramonitrophon* are restricted to the Magellan Province.

The *Trophons* are of world-wide distribution, but the southern typical members are most like northern *Boreotrophon*, again suggesting West American continuity, since the North Pacific is the stronghold of the latter genus.

Family Volutidae

The large heavy Volutes, *Adelomelon*, are South American and Magellanic. The Magellanic Tertiary-to-Recent *Miomelon* and the New Zealand Tertiary-to-Recent *Pachymelon-Palomelon* evidently had a common ancestry, yet no volutes of this style are known from intermediate areas.

The other high-latitude southern volutes belong to several specialized genera:

(1) *Harpovoluta*: A small thin-shelled Volute resembling the Buccinid *Voluthar pa*. Distribution: South Shetlands, Davis Sea and Macquarie Island (Tomlin, 1948).

(2) *Provocator*: A small, elongated, thin-shelled Volute from Kerguelen Island and between Falkland Islands and Patagonia.

(3) *Guivillea*: A large, thin-shelled Volute from Marion Island to the Crozets.

(4) *Paradmete*: Small, solid, *Mitra*-like shells closely allied to the boreal genus *Volutomitra*. Distribution: Kerguelen Island, off Tierra del Fuego, South Georgia, South Shetlands and Palmer Archipelago.

Family Turridae

The Turrids are represented by a number of regional genera of uncertain affinity with those from northern seas. The '*Bela*' complex covers several new genera and others that for the present have been left in this conventional location.

The large attractive *Aforia* is a splendid example of 'bipolar' distribution and has been dealt with in the previous section. Another member of the Cochlespirinae, *Leucosyrinx*, probably has a connected range up the eastern South American coast in deep water to the West Indies, where similar species to those from the Falklands-Scotia Arc localities are well represented.

A new genus of the Daphnelliinae, *Typhlodaphne*, from Magellan and South Georgia to Kerguelen, closely resembles *Typhlosyrinx* from deep water in the Gulf of Aden.

Family Acteonidae

The type genus *Acteon*, represented by magellanic and antarctic species, is cosmopolitan, but *Neactaeonina* is restricted to the Antarctic, ranging from South Georgia to the South Shetlands and eastwards to Kreguelen Island and the Ross Sea. Another subantarctic-antarctic genus, *Toledonia*, ranges from the Falkland Islands to the South Shetlands and eastwards to Kerguelen and the Ross Sea.

Family Philinidae

The cosmopolitan genus *Philine* is represented by four species: *kerguelensis* extends via the Atlantic-Indian Ocean cross-ridge from Kerguelen Island to north of the Falklands, *alata* from the Palmer Archipelago to the Davis Sea, *gibba* appears to be restricted to South Georgia and *falklandica* to the vicinity of the Falklands.

Family Scaphandridae

If my reference of a new South Georgian species to *Kaitoa* is correct, then this link with a Miocene New Zealand genus is of interest.

Family Siphonariidae

The characteristic subantarctic genus *Kerguelenella* ranges from the Magellan Province to South Georgia and eastwards to Kerguelen, the Macquarie Islands, and the subantarctic islands and Stewart Island of New Zealand. The genus shows relationship with the North Pacific boreal *Liriola*, but connecting links are no longer apparent.

SUMMARY

The above discussion shows that it is reasonable to suppose that the bulk of the southern high-latitude molluscan fauna could have been derived from the Americas, particularly the western coastline, which links more than two-thirds of the structural margin of the Pacific. Southern and eastern dispersal has been assisted by the continuity of the Americas in the Scotia Arc, which reaches the Antarctic Continent at Graham Land and in the Atlantic-Indian Ocean cross-ridge, which runs from the Argentine Basin almost to the Kerguelen-Gaussberg (radial) ridge. Possibly other radial extensions from Antarctica in former times may have operated also in distributing southern fauna to the Australian and New Zealand areas. The subantarctic cross-ridges may also have been much shallower during some former period than at the present time and thus more effective in distributing organisms more or less restricted to the Continental Shelf.

The prevailing West Wind Drift north of the Antarctic Circle and the opposite East Wind Drift to its south are present factors which must greatly facilitate the lateral distribution of many species.

With the exception of the Struthiolariidae, which have an ancestry extending back to the Cretaceous, the present southern high-latitude molluscan fauna presents no indication of antiquity. The bulk of the fauna probably results from a series of comparatively recent immigrations during Tertiary to Pleistocene times. There is a marked absence of archaic types such as *Pleurotomaria*.

INDEX TO THE DISCOVERY INVESTIGATIONS MOLLUSCA

(New species*, new genera†)

The report covers 215 species and includes descriptions of a new subfamily, the Solariellinae, 26 new genera and subgenera, and 46 new species and subspecies.

The material, including the types, will be deposited in the British Museum (Natural History).

PELECYPODA

GASTROPODA

ACKNOWLEDGEMENTS

The present work would have been impossible of accomplishment by one situated so far away from the libraries and collections associated with the larger and older scientific centres, but for the fortunate chance that the R.R.S. 'Discovery II' refitted in Auckland, New Zealand, during August 1932. Through the kindness of the late Commander W. M. Carey and the scientific staff under Mr Dilwyn John, I was allowed the privilege of referring to the extensive library of Antarctic reports in the ship's laboratory. During the six weeks of the vessel's stay in Auckland I worked constantly, typing relevant sections of text and photographing plates.

A subsequent visit to Sydney in 1937 enabled the completion of references by working on the extensive collection of separates accumulated by the late Mr Charles Hedley for his researches on the British Antarctic Expedition 1907–9 and the Australian Antarctic Expedition molluscan collections.

At the Australian Museum, Sydney, I examined their considerable collection of Antarctic Mollusca, and later received on loan from Dr Nils H. Odhner of Stockholm a representative series from the collections made by the Swedish South Polar Expedition.

My private collection of Mollusca, now deposited in the Auckland Museum, contains much southern material, and this has proved useful for comparative purposes.

For many requests for other comparative material I have to thank Mr J. R. le B. Tomlin of Sussex.

To all members of the Discovery Committee who have helped with this work, and to those specifically referred to above, I am most grateful.

SYSTEMATIC

PELECYPODA

Family NUCULANIDAE

Genus Propeleda Iredale, 1924

Type (o.d.): *Leda ensicula* Angas

Propeleda longicaudata

Leda longicaudata Thiele, 1912, p. 229, pl. 17, fig. 22.
Poroleda longicaudata Hedley, 1916, p. 18.
Propeleda longicaudata Iredale, 1924, p. 186.

TYPE LOCALITY. Gauss Station, Davis Sea, Antarctica.

St. 600. West of Adelaide I., Bellingshausen Sea, 67° 09′ S, 69° 27′ W., 17 Jan. 1931, 487–512 m. (one living example).

Length 16 mm.; height 6 mm. (holotype).

Length 21 mm.; height 6 mm. (Hedley, St. X, Davis Sea).

Length 26 mm.; height 10·25 mm. (St. 600).

As already noted by Hedley (1916), large examples tend to become proportionately narrower than small ones, e.g. the holotype. The rostrum tends to lengthen disproportionately to the rest of the shell.

Family LIMOPSIDAE

Genus Limopsis Sassi, 1827

Type (s.d. Gray, 1847): *Arca aurita* Brocchi, Miocene and Pliocene of Italy

Limopsis hirtella Rochebrune & Mabille.

Limopsis hirtella Rochebrune & Mabille, 1889, p. 115.
Limopsis hirtella Lamy, 1911 *a*, p. 25, pl. 1, figs. 18, 19, 20.

TYPE LOCALITY. Orange Bay, Patagonia.

St. WS 773. North of Falkland Is., 47° 28′ S, 60° 51′ W, 31 Oct. 1931, 291 m. (one valve, length 9·75 mm., height 9 mm., thickness 3 mm.).

RANGE. Patagonia (Rochebrune & Mabille); north of Falkland Is.; Petermann I. (Lamy).

Subgenus Felicia Rochebrune & Mabille, 1889

Type (monotypy): *Felicia jousseaumi* Rochebrune & Mabille

Limopsis (Felicia) jousseaumi (Rochebrune & Mabille).

Felicia jousseaumi Rochebrune & Mabille, 1889, p. 116, pl. 7, fig. 9*a*, *b*.
Limopsis jousseaumi Dall, 1908, p. 394.
Limopsis jousseaumei Lamy, 1911 *a*, p. 26.
Limopsis jousseaumei Thiele, 1912, p. 228.

TYPE LOCALITY. Beagle Channel, Tierra del Fuego.

St. 600. West of Adelaide I., Bellingshausen sea, 67° 09′ S, 69° 27′ W, 17 Jan. 1931, 487–512 m. (one living example, 34 × 28 × 11 mm., exclusive of periostracum).

RANGE. Beagle Channel, Tierra del Fuego (type); off Alexander Land, 297 m. (Lamy, 1911); off southern coast of Chile, 53° 1′ S in 369 fathoms (Dall, 1908).

Lamy (1911 *a*, p. 27) synonymized *Limopsis grandis* Smith (1907 *b*), with *jousseaumi*, but Thiele (1912) maintained them as distinct and figured the hinge characters of both. Dall (1908) did not recognize *Felicia*, as the 'absence of a fossette', upon which supposed character the genus was founded, was shown to be a misconception. However, these Antarctic, large, thin-shelled, deep-water Limopsids would seem to be worth separating subgenerically on account of the relatively small, weakly developed hinge and tiny fossette. Related species are: *grandis* Smith (1907 *b*), from Davis Sea, 254 fathoms; *marionensis* Smith, 1885 from off Marion Island in 140 fathoms; *laeviuscula* Pelseneer, 1903 from 71° S, 89° W; and *longipilosa* Pelseneer (1903), from 71° 22′ S, 16° 34′ W in 1410 fathoms.

Genus Lissarca Smith, 1877

Type (monotypy): *Arca* (*Lissarca*) *rubrofusca* Smith

Lissarca cf. **notorcadensis** Melvill & Standen

Lissarca notorcadensis Melvill & Standen, 1907, p. 144, figs. 14, 14*a*.
Arca (*Bathyarca*) *gourdoni* Lamy, 1911 *a*, p. 28, pl. 1, figs. 21, 22.
Lissarca gourdoni Thiele, 1912, p. 228, pl. 18, fig. 3.
Lissarca notorcadensis Smith, 1915, p. 75.
Lissarca notorcadensis Hedley, 1916, p. 19.

TYPE LOCALITIES. Scotia Bay, South Orkneys, 9–15 fathoms (*notorcadensis*); Alexander I., 250 m., Bellingshausen Sea (*gourdoni*).

St. WS 838. Between Patagonia and Falkland Is., 53° 11′ 45″ S, 65° W, 5 Feb. 1932, 148 m. (one living example).

RANGE. Alexander I. (Lamy); South Orkneys (Melvill & Standen); Gauss Station (Thiele); Commonwealth Bay, Adelie Land, 25–400 fathoms (Hedley); Ross Sea, 140–160 fathoms (Smith).

The reference of the St. WS 838 specimen to the above species is not certain, for the single example is not adult.

Family PANDORIDAE

Genus **Pandora** Lamarck, 1799

Subgenus **Kennerlia** Carpenter, 1864

Type (s.d. Dall, 1903): *K. filosa* Carpenter. Recent, North-west America

Pandora (Kennerlia) braziliensis Sowerby

Pandora braziliensis Sowerby, 1874*b*, pl. 2, fig. 15.
Pandora (*Kennerlia*) *braziliensis* Smith, 1881, p. 40, pl. 5, fig. 4*a–c*.

St. WS 854. Off Cape Dos Bahias, Patagonia, 22 Mar. 1932, 97–97 m.

The species has been recorded previously from the Magellan Province by Smith (1881), i.e. Port Rosario, 2–30 fathoms.

Family HIATELLIDAE

Genus **Hiatella** Daudin, 1801

Hiatella antarctica (Philippi)

Saxicava antarctica Philippi, 1845, p. 51.
Saxicava sp. (cf.) *antarctica* Smith, 1881, p. 40.
Saxicava antarctica Rochebrune & Mabille, 1889, p. H. 102.
Saxicava arctica var. *antarctica* Melvill & Standen, 1907, p. 121.
Saxicava antarctica Thiele, 1912, p. 256.
Saxicava antarctica Hedley, 1916, p. 33.

Type locality. Strait of Magellan.

St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229 m., 227–236 m.
St. WS 834. Below eastern entrance to the Strait of Magellan, 2 Feb. 1932, 27–28 m.
St. WS 836. Off Patagonia, 53° 05′ 30″ S, 67° 38′ W, 3 Feb. 1932, 64 m.

Range. Patagonia (Philippi, 1845; Rochebrune & Mabille, 1889); Gough I., 100 fathoms and Burdwood Bank, 56 fathoms (Melvill & Standen, 1907); Kerguelen I. (Thiele, 1912); Macquarie I. (Hedley, 1916).

Shells of the nestling habit are so variable in shape that it is almost impossible to select characters of any taxonomic importance. It seems reasonable to suppose that there is only one wide-ranging southern species. The following nominal species have been described from Antarctic and Subantarctic Seas: *antarctica* Philippi, 1845, Strait of Magellan; *bisulcata* Smith, 1879, Kerguelen Island; *chilensis* Hupé (Gay), Calbuco, Chile; *frigida*, *lebruni* and *mollis* Rochebrune & Mabille, 1889, Orange Bay, Patagonia; and *subantarctica* Preston, 1913, Falkland Islands.

GASTROPODA

Family SCISSURELLIDAE

Genus **Schizotrochus** Monterosato, 1877

Type: *Scissurella crispata* Fleming

Schizotrochus euglyptus (Pelseneer)

Scissurella euglypta Pelseneer, 1903, p. 17, pl. 4, figs. 43–45.
Scissurella euglypta Thiele, 1912, p. 187.
Scissurella euglypta Melvill & Standen, 1912, p. 345.

Type locality. *Circa* 70° S, 83–87° W.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W, to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.

St. 190. Bismarck Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Mar. 1927, 93–130 m. (one broken specimen).

RANGE. Recorded also from Gauss Station, Davis Sea (Thiele, 1912) and Burdwood Bank, 56 fathoms, south of Falkland Is. (Melvill & Standen, 1912).

Family PATELLOIDIDAE

Genus Patelloida Quoy & Gaimard, 1834

Type (s.d. Gray 1847): *Acmaea rugosa* Quoy & Gaimard=*Acmaea* Eschscholtz, 1833 non *Acmea* Hartmann, 1821 (see Winckworth, 1934)

Patelloida ceciliana (Orbigny)

Patella ceciliana Orbigny, 1841, p. 482, pl. 81, figs. 4–6.
Patella ceciliana (Gay) Hupé, 1854, p. 260.
Acmaea ceciliana Tryon & Pilsbry, 1891, p. 33, pl. 34, figs. 14–21.
Acmaea ceciliana Melvill & Standen, 1907, p. 126.

TYPE LOCALITY. Falkland Is.?

St. 51. Off Eddystone Rock, east of Falkland Is. from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m. (one dead shell). Falkland Islands (A.W.B.P. coll. Auck. Mus.).

RANGE. Antofagasta to Valparaiso, Chile (Dall, 1909); Falkland Is. (Melvill & Standen, 1898, 1901, 1907).

Strebel (1907) described a subspecies *magellanica* from Tierra del Fuego.

Family PATELLIDAE

Genus Nacella Schumacher, 1817

Type (s.d. Gray, 1847): *Patella mytilina* Helbling

The genus is here restricted to the thin, ovate shells with anterior apex. The thicker shelled southern limpets with a bronze iridescence and subcentral apex, usually included in *Nacella*, are here segregated into *Patinigera*. True *Nacella* lives upon the giant seaweeds, *D'Urvillea* and *Macrocystis*.

Nacella mytilina (Helbling)

Patella mytilina Helbling, 1779, p. 104, pl. 1, figs. 5, 6.
Patella mytilina Gmelin, 1791, p. 3698.
Patella conchacea Gmelin, 1791, p. 3708.
Nacella mytiloides Schumacher, 1817, p. 179.
Nacella mytilina Dall, 1870, p. 274.
Nacella compressa Rochebrune & Mabille, 1889, p. 98, pl. 5, fig. 9.
Nacella mytilina Pilsbry, 1891, p. 115, pl. 50, figs. 32–39.
Nacella mytilina Smith, 1905, p. 336.
Patella mytilina Strebel, 1907, p. 113, pl. 3, fig. 44; pl. 4, figs. 49, 51–55, 57, 57*a*, 59.
Nacella mytilina Thiele, 1912, p. 234.
Nacella falklandica Preston, ?1913, p. 221, pl. 4, fig. 6.
Nacella mytilina Melvill & Standen, 1914, p. 114.

The following are probable synonyms also: *Patella cymbularia* Lamarck (1819), Strait of Magellan; *P. hyalina* Philippi (1845) (maintained as distinct by Melvill & Standen, 1914); and *P. vitrea* Philippi (1845) (maintained as distinct by Strebel, 1907). Preston's *Nacella falklandica* appears to be an individual variant of *mytilina* with strong radials. I have typical examples of *mytilina* from Port Stanley, Falkland Islands, collected by Mr A. G. Bennett.

TYPE LOCALITY. Strait of Magellan.

St. 222. St Martin's Cove, Hermite Island, Cape Horn, 24 April. 1927, on *Macrocystis*.

RANGE. Strait of Magellan; Tierra del Fuego (Smith, 1905); Falkland Is. (Strebel, 1907; Melvill & Standen, 1914; A. G. Bennett, loc. cit.); Kerguelen I. (Thiele, 1912).

Length 27·00 mm.; breadth 18·0 mm.; height 7·5 mm. (St. 222).

Length 35·75 mm.; breadth 22·5 mm.; height 11·0 mm. (Falkland Islands).

Length 41·00 mm.; breadth 24·0 mm.; height 17·0 mm. (Pilsbry, 1891).

Genus Patinigera Dall, 1905

n.nom. for *Patinella* Dall, 1871 *non* Gray, 1848

Type (o.d.) *Patella magellanica* Gmelin

This genus and *Nacella* have the gill cordon continuous and the foot encircled by a scalloped epipodial ridge, which is interrupted in front by the head. They both differ in these respects from *Cellana*, which has an incomplete branchial cordon and no epipodial ridge.

The shell in *Patinigera* has a subcentral apex and is of normal shape and solidity, as in *Patella* and *Cellana*, but is at once distinguished by the bronzy lustre of the nacreous interior.

The range of *Patinigera* covers most of the Antarctic and Subantarctic, but *Nacella* seems to be restricted to the Subantarctic from the Magellan region to Kerguelen Island.

The valid species and subspecies of *Patinigera* appear to be as follows: *clypeata* (Lesson, 1830), Valparaiso, Chile; *magellanica* (Gmelin, 1791), Strait of Magellan, Tierra del Fuego and southern Patagonia; *magellanica venosa* (Reeve, 1854) (=*chiloensis* Reeve, 1855), Island of Chiloe, Chile; *fuegiensis* (Reeve, 1855), Subantarctic, Tierra del Fuego to Kerguelen Island; *aenea* (Martyn, 1784) (=*deaurata* Gmelin, 1791), Straits of Magellan, eastern Tierra del Fuego and Falkland Islands; *polaris* (Hombron & Jacquinot, 1841), Antarctic, South Georgia and Seymour Island to Bouvet Island; *polaris concinna* (Strebel, 1908), South Georgia; *kerguelenensis* (Smith, 1879), Kerguelen Island and Macquarie Island?; *macquariensis* (Finlay, 1926), Macquarie Island; and *terroris* (Filhol, 1880), Campbell Island.

I have not seen *fuegiensis* (Reeve, 1855), a seaweed-frequenting species, or *delesserti* (Philippi, 1849), Marion Island, probably distinct, or *depsta* (Reeve, 1855, Island of St Paul) which may be a *Cellana*.

Patinigera magellanica Gmelin

Patella magellanica Gmelin, 1791, p. 3703.
Patella atramentosa Reeve, 1854, fig. 41.
Patella magellanica Reeve, 1854, fig. 19.
Patella meridionalis Rochebrune & Mabille, 1885, p. 109.
Patella tincta Rochebrune & Mabille, 1885, p. 110.
Patella pupillata Rochebrune & Mabille, 1885, p. 120.
Patella metallica Rochebrune & Mabille, 1885, p. 109.
Nacella aenea magellanica Pilsbry, 1891, p. 119, pl. 44, figs. 9–12, 15, 16.

TYPE LOCALITY. Strait of Magellan.

Possession Bay Patagonia (Hassler Exped. 1872, ex Mus. Comp. Zool. Massachusetts).
Straits of Magellan, Chile (W. J. Eyerdam, 1939).

RANGE. Magellan, Patagonia and Tierra del Fuego.

This is a solid, high-conical, rounded-oval shell with strong, rather smooth radial ribs. The central area is dark bronzy brown.

Reeve's *venosa* (=*chiloensis*), from the Island of Chiloe, is a relatively smooth, more rounded form, which may be a regional subspecies.

Length 51 mm.; breadth 40 mm.; height 28 mm. (Straits of Magellan).

Length 51 mm.; breadth 38·5 mm.; height 25 mm. (Possession Bay).

Length 46 mm.; breadth 43 mm.; height 25 mm. (Straits of Magellan).

Patinigera aenea (Martyn)

Patella aenea Martyn, 1784, pl. 17.
Patella deaurata Gmelin, 1791, p. 3719.
Patella varicosa Reeve, 1854, fig. 21.
Nacella strigatella Rochebrune & Mabille, 1885, p. 110.
Nacella aenea and *aenea deaurata*, Pilsbry, 1891, pp. 117, 118, pl. 15, figs. 5, 6; pl. 45, figs. 22, 23; pl. 46, figs. 28–36.
Patinella deaurata Strebel, 1908, p. 80.
Helcioniscus bennetti Preston, 1913, p. 221, pl. 4, fig. 7.

Strebel's *Patinella delicatissima* (1907, p. 145 and 1908, pl. 1, figs 75, 75*a*) is a benthic form of the above.

Type locality. Strait of Magellan.

North-east coast, Tierra del Fuego (R. T. Reynolds, 1934); Falkland Is. (W. R. le. B. Tomlin & A. G. Bennett).

Range. Tierra del Fuego, Strait of Magellan and Falkland Is.

This species is larger and more elongate-ovate than *magellanica* and has the strong radial ribs prominently scaled by the concentric growth lines. Thin shells with a near anterior apex were subspecifically separated as *deaurata* by Pilsbry (1891), but this does not seem warranted. If, however, the move to ban Martyn's names becomes generally accepted, then Gmelin's *deaurata* must come into use for the species.

Length 33·5 mm.; breadth 23·0 mm.; height 10·0 mm. (Falkland Islands).
Length 55·5 mm.; breadth 38·0 mm.; height 23·0 mm. (Falkland Islands).
Length 60·5 mm.; breadth 43·0 mm.; height 25·5 mm. (Falkland Islands).
Length 70·0 mm.; breadth 46·0 mm.; height 32·0 mm. (Tierra del Fuego).

Patinigera delicatissima (Strebel)

Patinella delicatissima Strebel, 1907, p. 145, pl. 5, figs. 71, 72.
Patinella delicatissima Strebel, 1908, pl. 1, figs. 75, 75*a*.
Patella delicatissima Melvill & Standen, 1914, p. 114.

Type locality. Strait of Magellan, 20–30 fathoms.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 115 m.
St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 1½ cables N 50° E of Sparrow Point, 16 May 1926, 10½–16 m.

This is a small, thin species of low profile with delicately squamose ribs. It is apparently constant and not merely a benthic form of *aenea*. Strebel (1907) recorded it from Berkeley Sound, 16 m., and Port Louis, 7 m., Falkland Islands, and Melvill & Standen (1907) from Rapid Point and Roy Cove, West Falkland Islands, at low water.

Patinigera polaris (Hombron & Jacquinot)

Patella polaris Hombron & Jacquinot, 1841, p. 191.
Patella polaris Martens & Pfeffer, 1886, p. 101, pl. 2, figs. 11–13.
Nacella polaris Pilsbry, 1891, p. 120, pl. 49, figs. 21–27.
Patinella polaris Strebel, 1908, p. 81, pl. 5, fig. 77.
Nacella (*Patinella*) *polaris* Lamy, 1911*a*, p. 15.
Nacella (*Patinigera*) *polaris* L. David, 1934, nos. 2–3, p. 127.

TYPE LOCALITY. South Georgia (littoral).

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, Shore Coll.
St. 163. Paul Harbour, Signy I., South Orkneys, 17 Feb. 1927, 18–27 m.
St. 164. East end of Normanna Strait, South Orkneys, 18 Feb. 1927, 24–36 m.
St. 166. South-east point of Paul Harbour, Signy I., South Orkneys, 19 Feb. 1927, Shore Coll.
St. 173. Port Foster, Deception I., South Shetlands, 28 Feb. 1927, 5–60 m.
St. 179 Melchior I., Schollaert Channel, Palmer Archipelago, in creek to south of south-west anchorage, 10 Mar. 1927, 4–10 m.
St. 456. 1 mile east of Bouvet I., 18 Oct. 1930, 40–45 m.
St. 1092. Signy I., South Orkneys, 23 Jan. 1933, Shore Coll.
St. 1486. Harmony Cove, Nelson I., South Shetlands, 3 Jan. 1935, Shore Coll.
St. 1487. Desolation I., Livingston I., South Shetlands, 8 Jan. 1935, Shore Coll.
Wilhelmina Bay, Danco Land, South Shetlands, 64° 30′ S, 62° W, 8 Feb. 1922, 1–8 fathoms, A. G. Bennett.
St. WS 564. Moltke Harbour, South Georgia, 24 Feb. 1931, in rock pool.

RANGE. South Georgia, South Orkneys, South Shetlands, Palmer Archipelago and Bouvet Island ('Discovery'), Seymour I. and Paulet I. (Strebel, 1908), 0–60 m.

This strictly Antarctic limpet is, typically, large, elevated, oblongovate, lightly built, sparingly and weakly radially ribbed, mostly smooth, drab externally and more or less uniformly bronzy black within. Examples from below the littoral are of paler colour—bronzy reddish brown within.

Length 51 mm.; breadth 36 mm.; height 23 mm. (South Georgia).
Length 48 mm.; breadth 35 mm.; height 26 mm. (South Georgia).
Length 48 mm.; breadth 34 mm.; height 25 mm. (South Shetlands, St. 1487).
Length 58 mm.; breadth 42 mm.; height 19 mm. (Palmer Archipelago, St. 179).

Patinigera polaris concinna (Strebel)

Patinella polaris concinna Strebel, 1908, p. 82, pl. 5, figs. 76*a–e*, 78*a*, *b*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 15–25 m.

A. Typical form, with crisp radials:

St. 145. Stromness Harbour, South Georgia, between Grass I. and Tonsberg Point, 7 Jan. 1927, 26–35 m.
St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.
St. MS 12. East Cumberland Bay, 1 cable E to 1 mile S × E½, east of Hobart Rock, South Georgia, 17 Feb. 1925, 25–53 m.
St. MS 66. East Cumberland Bay, 2¼ miles south-east of King Edward Point Lt. to 1½ cables W × N of Macmahon Rock, South Georgia, 28 Feb. 1926, 18 m.

B. Depressed form, radials obsolete towards margin:

St. MS 6. East Cumberland Bay, ¼ mile south of Hope Point to 1¼ cables S × E of King Edward Point Lt., 12 Feb. 1925, 24–30 m.
St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, 14 Feb. 1925, 27 m.
St. MS 71. East Cumberland Bay, 9¼ cables E × S to 1·2 miles E × S of Sappho Point., South Georgia, 9 Mar. 1926, 110–60 m.

RANGE. South Georgia, 15–110 m.

A benthic form of *polaris*. Typically it is small, thin-shelled, moderately elevated, with narrow, crisp radials crossed by dense concentric growth lines. Colour buff, blotched or variously marked in reddish brown. With it (Form B) is a very depressed form which reaches a larger adult size and is probably the adult *concinna*. It commences with crisp radials on a normally conic shell, but later flattens out, the radials become either obsolete or are present as very weak corrugations, but the concentric growth lines persist over the whole shell.

The *concinna* form is represented in the collections only from South Georgia. Benthic shells from the South Orkneys and South Shetlands have the shape and sculpture of typical *polaris*.

Form A (typical):

Length 27·25 mm.; breadth 19·0 mm.; height 8·0 mm. (St. MS 12).
Length 28·75 mm.; breadth 20·0 mm.; height 8·5 mm. (St. MS 66).
Length 20·70 mm.; breadth 14·0 mm.; height 4·5 mm. (Strebel, 1908).
Length 32·00 mm.; breadth 21·5 mm.; height 7·7 mm. (Strebel, 1908).

Form B:

Length 35·75 mm.; breadth 24·6 mm.; height 8·5 mm.
Length 36·00 mm.; breadth 24·5 mm.; height 7·0 mm.
Length 39·50 mm.; breadth 27·5 mm.; height 9·5 mm.
Length 42·00 mm.; breadth 29·0 mm.; height 9·0 mm.
} (St. MS 10).

A near relative to *polaris* is the Kerguelen Island *Patella* (*Patinella*) *kerguelenensis* Smith (1879, p. 177, pl. 9, figs. 13, 13*a*). This has a large thin elevated shell with subobsolete radial sculpture, very like *polaris* except for a constant narrowing of the anterior end which results in a true oval outline. Hedley (1916, p. 44) recorded this species from Macquarie Island, but I have not seen the material.

Family LEPETIDAE

Genus **Lepeta** Gray, 1840

Type (monotypy): *Patella caeca* Mueller, Boreal Seas

Lepeta coppingeri (Smith)

Tectura (*Pilidium*) *coppingeri* Smith, 1881, p. 35, pl. 4, figs. 12, 12*a*.
Tectura coppingeri Rochebrune & Mabille, 1889, p. H. 90.
Lepeta coppingeri Pilsbry, 1891, p. 71, pl. 39, figs. 20, 21.
Lepeta (*Pilidium*) *antarctica* Smith, 1907, p. 12, pl. 2, figs. 11, 11*a*.
Pilidium coppingeri Strebel, 1907, p. 110, pl. 3, fig. 38.
Pilidium coppingeri Strebel, 1908, p. 83.
Lepeta antarctica Hedley, 1911, p. 4.
Lepeta coppingeri Smith, 1915, p. 62.
Lepeta coppingeri Hedley, 1916, p. 41.
Lepeta coppingeri Eales, 1923, p. 6.

Type localities. Sandy Point, 9–10 fathoms, Patagonia (*coppingeri*); McMurdo Sound, 130 fathoms (*antarctica*).

St. 1652. Ross Sea, 75° 56·2′ S, 178° 35·5′ W, 23 Jan. 1936, 567 m. (one example).
St. WS 246. Off south end of West Falkland Is., 52° 25′ S, 61° W, 19 July 1928, 267–208 m. (one empty shell).

Family FISSURELLIDAE

Genus **Fissurella** Lamarck, 1799

Type (monotypy): *Patella nimbosa* Linné, 1758

Subgenus **Balboaina** Farfante, 1943

Type (monotypy): *Patella picta* Gmelin, 1791

The subgenus *Balboaina* was proposed for large species (up to 100 mm. in length) with the shell margin entirely in one plane, not crenulated and with a broad dark internal border. Orifice a little in front of the middle and surrounded internally by a broad callus. Distribution: Chile and Magellan Province.

Fissurella (Balboaina) picta (Gmelin)

Patella picta Gmelin, 1791, p. 3729.
Fissurella picta Hupé (Gay), 1854, p. 237.
Fissurella picta Rochebrune & Mabille, 1889, p. 70.
Fissurella picta Pilsbry, 1890, p. 144, pl. 45, figs. 9–11.
Fissurella picta Melvill & Standen, 1907, p. 98.
Fissurella picta Strebel, 1906, p. 83.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m. (small dead shells only).
Port Stanley, Falkland Is. (A. G. Bennett and J. R. le B. Tomlin).

RANGE. Valparaiso, Chile (Pilsbry, Gay); Tierra del Fuego (Strebel); Santa Cruz, Punta Arenas and Baie Orange (Rochebrune and Mabille); Port Stanley, Falkland Is. (Melvill & Standen and Strebel).

Length 17·5 mm.; breadth 11·0 mm.; height 4·0 mm. (St. 51).
Length 60·0 mm.; breadth 39·0 mm.; height 16·0 mm. (Falkland Islands).
Length 84·5 mm.; breadth 54·5 mm.; height 26·0 mm. (Falkland Islands).
Length 86·0 mm.; breadth 55·5 mm.; height 27·0 mm. (Falkland Islands).

Fissurella (Balboaina) oriens Sowerby

Fissurella oriens Sowerby, 1834, p. 124.
Fissurella oriens Pilsbry, 1890, p. 152, pl. 46, figs. 18, 19; pl. 34, fig. 58.
Fissurella oriens Strebel, 1906, p. 88, pl. 1, figs. 8–14; pl. 2, figs. 15–20.
Fissurella oriens Melvill & Standen, 1907, p. 97.
Fissurella oriens Strebel, 1908, p. 78, pl. 6, fig. 97*a*, *b*.

TYPE LOCALITY. Valparaiso, Chile.

St. 51. Off Eddystone Rock, East Falkland Is., 4 May 1926, 105–115 m. (one small empty shell).
Port Stanley, Falkland Is. (ex Australian Museum).

Length 24·0 mm.; breadth 12·0 mm.; height 4·0 mm. (Falkland Islands).
Length 43·0 mm.; breadth 23·0 mm.; height 8·0 mm. (Falkland Islands).
Length 46·0 mm.; breadth 27·0 mm.; height 11·0 mm. (Pilsbry).

RANGE. Coast of Chile and Island of Chiloe (Pilsbry); various Magellan localities including Falkland Is. (Strebel); Port William, Falkland Is. (Melvill & Standen, shore; Strebel, 12 m.).

The two species occur together at the Falkland Islands, but do not seem to intergrade. The species *picta* reaches a large size, has an ovate outline, and the length of the orifice is one-seventh to one-eighth that of the shell; '*oriens*' is smaller, narrow, with parallel sides, and the length of the orifice is one-sixth that of the shell. The former is white, conspicuously rayed with dark purplish brown and the latter diffused greyish and reddish purple, in concentric zones and crossed by reddish radials. I have no topotypic material of *oriens*, so cannot comment on the correctness or otherwise of applying the name of a Chilean species to Falkland Islands material.

Genus **Megatebennus** Pilsbry, 1890

Type (o.d.): *Fissurellidea bimaculata* Dall, California

Megatebennus patagonicus Strebel

Megatebennus patagonicus Strebel, 1907, p. 98, pl. 2, fig. 23*a–f*.
Megatebennus patagonicus Strebel, 1908, p. 79.

TYPE LOCALITY. Lennox I., Tierra del Fuego.

St. 57. Port William, East Falkland Is., $5\frac{1}{2}$ cables S 20° W of Sparrow Point, 16 Ma 1926, 15 m. (one example).

Genus Puncturella Lowe, 1827

Type (o.d.): *Patella noachina* Linn.

The southern Puncturellas have long proved to be a stumbling block, and most authors have lumped the southern records with the boreal *noachina*. Certainly on external shell characters there is no marked difference between the northern *noachina* and the Antarctic-Subantarctic shells.

Dall, however (1889*a*, pp. 356–7), revived *falklandica* A. Adams for shells from 449 fathoms, west coast of Patagonia. He remarked concerning these Patagonian shells that they are 'amazingly like *P. noachina*; the only differences I have been able to see in the shells are that in *P. noachina* the fissure is generally longer and less vertical, and the apex more posterior'.

Dall did not examine the dentition of his southern shells, but I have found the radula of *conica* (=*falklandica*) from St. 27, South Georgia, to show striking differences from the figures of the Greenland *noachina* in Troschel & Thiele (1891, pl. 27, fig. 2).

Allowing for differences in interpretation of these small radulae, especially difficult in the Rhipidoglossa, owing to the numerous minute and crowded marginals and the large hooked outer lateral, which assumes a different shape with the varying angles taken up in mounting, there is a marked difference between the central and inner laterals in northern and southern examples. Since the central and inner laterals always lie in one flat plane, and are easily seen, the differences noted between Troschel & Thiele's figure and my slides demonstrate that in spite of similarity in the shells *noachina* can no longer be applied to these southern shells.

The difficulty, now, is to determine how many of the names that have been proposed for southern shells represent valid species, and which of these names is applicable to the Discovery material.

Rimula conica d'Orbigny (1841, p. 471) from the Falkland Islands is a juvenile of 4 mm. in length, tall and strongly recurved at the apex. It can be matched exactly with young examples from the Discovery material.

Cemoria princeps Mighels (1841, p. 42, pl. 4, fig. 9), type locality Maine, is a synonym of typical *noachina*.

Puncturella cognata Gould (1852, p. 321, pl. 31, fig. 478), Orange Harbour, 16 fathoms, Patagonia, is not so laterally compressed and has weaker sculpture than the Discovery material.

P. analoga Martens (1903, p. 70, pl. 5, fig. 8), Kerguelen Island (length 8 mm., breadth 5 mm., height 5 mm.), is sculptured with strong radials and can be matched with half-grown shells from the Discovery material. Recorded from Macquarie Island by Hedley (1916, p. 37), and Tomlin (1948).*

P. spirigera Thiele (1912). Evidently a distinct species with regular ribs separated by linear grooves; a tall shell with strongly recurved apex.

Puncturella conica (d'Orbigny)

Rimula conica d'Orbigny, 1841, p. 471.
Cemoria falklandica A. Adams, 1862, p. 208, fig. 14.
Puncturella noachina Watson, 1886, p. 42.
Puncturella falklandica Dall, 1889*a*, p. 356.
Puncturella falklandica Pilsbry, 1890, p. 231, pl. 63, fig. 33.
Puncturella analoga Martens, 1903, p. 70, pl. 5, fig. 8.
Puncturella noachina Strebel, 1907, pl. 2, figs. 24*a–c*, 25*a–d*.
Puncturella noachina Strebel, 1908, p. 79.
Puncturella noachina Thiele, 1912, p. 234.
Puncturella noachina (='*falklandiana*' sic): Melvill & Standen, 1912, p. 344.

* Since the above was written I have examined this B.A.N.Z.A.R.E. material consisting of fifty-one specimens, and find that they are constant in having very weakly developed radials. These Macquarie Island shells are probably neither *conica* nor *analoga*, but topotypes of the latter are required to determine this.

TYPE LOCALITIES. Falkland Is. (*conica* and *falklandica*); Kerguelen I. (*analoga*).

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason I., 15 Mar. 1926, 110 m.
St. 42. Off mouth of Cumberland Bay, South Georgia, 1 Apr. 1926, 120–204 m.
St. 144. Off mouth of Stromness Harbour, South Georgia, 5 Jan. 1927, 155–178 m.
St. 156. Off north coast of South Georgia, 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.
St. 159. North-east of South Georgia, 52° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.
St. 170. Off Cape Bowles, Clarence Is., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.
St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 1562. Near Marion I., from 46° 51′ 7″ S, 37° 56′ 5″ E to 46° 54′ 8″ S, 37° 53′ 8″ E, 7 Apr. 1935, 97–104 m.
St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 25 Mar. 1927, 79 m.
St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229–236 m.
St. WS 246. South-west Falkland Is., 52° 25′ S, 61° W, 19 July 1928, 267–208 m.
St. WS. 799. North-west of Falkland Is. 48° 04′ 15″ S, 62° 48′ 07″ W, 21 Dec. 1931, 141–137 m.
St. WS 824. South-east of Falkland Is., 52° 29′ S, 58° 27′ W, 19 Jan. 1932, 146–137 m.
St. MS 71. East Cumberland Bay, 9¼ cables E × S to 1·2 miles E × S of Sappho Point, 9 Mar. 1926, 110–60 m.

RANGE. Approximately Magellan to Kerguelen I. (possibly Macquarie Island) and south to Bransfield Strait, 60–342 m. (449 fathoms, Dall, 1889, loc. cit.).

Length 16·0 mm.; breadth 9·8 mm.; height 11·4 mm. (St. 27).
Length 9·0 mm.; breadth 6·0 mm.; height 5·2 mm. (St. WS 228).
Length 8·8 mm.; breadth 6·0 mm.; height 6·8 mm. (St. 170).
Length 7·0 mm.; breadth 5·25 mm.; height 4·25 mm. (*noachina*, Pilsbry, 1890, p. 230).

Forbes & Hanley (1850) state that their largest example of *noachina* 'measures four lines in breadth and rather exceeds five in length'.

DENTITION. (Fig. G, 2, p. 189, from example of length 16 mm., breadth 9·8 mm., height 11·4 mm., St. 27.) The four laterals are all narrow and lie erect and parallel to the axis of the central, not oblique to it as in *noachina* (Fig. G, 1, p. 189).

Genus Parmaphorella Strebel, 1907

Type (monotypy): *Tugalia antarctica* Strebel 1907 (*non* Melvill & Standen 1907)
(See Tomlin, 1932, p. 163)

Parmaphorella melvilli (Thiele)

Tugalia antarctica Melvill & Standen, 1907, p. 98, pl., fig. 1 (*non* Strebel, 1907).
Tugalia melvilli Thiele, 1912, p. 257.

TYPE LOCALITY. Burdwood Bank, South of Falkland Is. in 56 fathoms.

St. 388. Off Tierra del Fuego, 56° 19½′ S, 67° 09¾′ W, 16 Apr. 1930, 121 m.
St. WS 825. North-east of Falkland Is., 50° 50′ 00″ S, 57° 15′ 15″ W, 18–19 Jan. 1932, 135–144 m.

DENTITION. Fig. G, 3, p. 189. $\infty+(1+1+4)+1+(4+1+1)+\infty$. Central tooth broad but reduced above to a comparatively narrow cutting edge. Four narrow laterals lying parallel to the oblique sides of the central—fourth lateral pointed but without a cutting edge—fifth lateral massive, hooked and with a prominent cusp in addition to the terminal cutting point. There is a sixth incipient or obsolescent lateral, which is less than half the size of the fifth. Similar accessory plates are shown in *Puncturella* and in Thiele's figures of the dentition of several Fissurellids, e.g. *Emarginula obovata*, *E. elongata* and *Scutus australis* (1891). The marginals are very numerous, slender and curved, and all are delicately cusped towards the outer extremity.

Three species of the genus are known: *antarctica* (Strebel, 1907) from Strait Le Maire, Tierra del Fuego; *melvilli* (Thiele, 1912) and *barnardi* (Tomlin, 1932) from Cape Point, South Africa, in 180 fathoms.

THE TROCHACEA

The radula

The Rhipidoglossid radula is undoubtedly one of the most difficult to interpret owing to the large number and the intricate overlapping of the teeth. In the Calliostomid radula in particular, long, slender, foliated cusps form a complicated network that effectively obscures the form of the bases of the individual teeth unless these teeth are laboriously segregated on the slide. Even then it is difficult to estimate the outlines these teeth would present when viewed from above in their natural working position. Each angle from which an individual tooth is observed gives a different result, especially with the laterals.

I have achieved the best results, where there is sufficient material, by mounting several radulae—one stained with eosin and mounted in Canada balsam, one unstained and mounted in glycerine jelly and one or more in either medium with individual teeth and groups of teeth segregated from the mass. Staining is essential to bring out the form of the base, but by this method the elaborate foliated cusps so characteristic of the Calliostomids are not easily seen. On the other hand, glycerine jelly brings out detail of the cusps to perfection but shows little else.

In general terms the dental formula of the Trochacea consists of a central tooth, four to sixteen laterals (usually four to five) and a large number of marginals (usually too many to count with accuracy (expressed as ∞)). The inner marginal in the Calliostomidae is always massive and clearly the most effective working tooth. The rest of the teeth are so delicate that they can scarcely be operative in mastication.

The radula types covered by the present material are as follows:

A. Marginal teeth very numerous.
- *a.* Central and laterals with long, slender, foliated cusps.
  - *aa.* Inner marginal massive, crooked, with cusps on lower edge. — **Calliostomatinae**
- *b.* Central and lateral teeth with short denticulated cusps.
  - *bb.* Inner marginal not noticeably larger or more massive than neighbouring ones — **Stomatellinae = Margaritinae**
    - Transverse rows forming a simple arc — **Margarites**
    - Transverse rows with a slight dip at the middle — **Margarella**

B. Marginal teeth few (5–10).
- Transverse rows with a pronounced dip at the middle. — **Solariellinae**

The epipodial processes

Interesting confirmation of differences shown by study of the Trochoid radula is shown by the tentacles or filaments associated with the epipodial fringe.

Calliostoma Swainson, 1840 (type: *Calliostoma zizyphinum* (Linn.) England).

Two long, slender cephalic tentacles with the eyes at the extremities of a pair of short tentacles, each close against the outer side of the base of one of the long tentacles. Epipodial tentacles, three on each side of the foot, long and slender (see Forbes & Hanley, 1851, 3, pl. EE and Fischer, 1887, p. 826, fig. 585).

1. **Calliostoma modestulum** Strebel. Two long slender cephalic tentacles and eyes as in *Calliostoma* typical. Epipodial tentacles four on each side of the foot, long and slender (Fig. D, 1).

Dall (1889 *a*, p. 343), in describing *C. platinum*, 414 fathoms, California, stated that there were four moderate-sized epipodial 'filaments' and that the tentacles were long and slender.

In *Venustas cunninghami* (Griffiths & Pidgeon), New Zealand, the cephalic tentacles are short and stout and there are four pairs of short epipodial tentacles.

2. **Photinula coerulescens** (King & Broderip). Two short cephalic tentacles. Epipodial tentacles six pairs, slender, moderately long, and of approximately equal size (Fig. D, 4).

3. **Photinastoma taeniata** (Wood). Two short cephalic tentacles. Epipodial tentacles four pairs, rather short and stout and of equal size (Fig. D, 2).

4. **Venustatrochus georgianus** n.g. and n.sp. Two long and slender cephalic tentacles. Epipodial tentacles seven pairs, all slender, first two short, remainder long (Fig. D, 6).

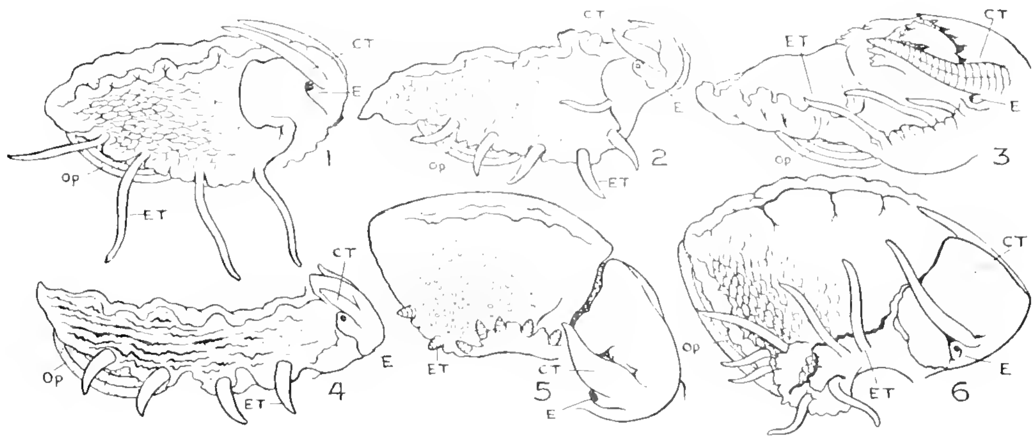

Fig. D. Epipodial processes in Trochoids. *CT* = cephalic tentacles, *ET* = epipodial processes and *Op* = opercula in: (1) *Calliostoma modestulum* Strebel; (2) *Photinastoma taeniata* (Wood); (3) *Solariella kempi* n.sp.; (4) *Photinula coerulescens* (King & Broderip); (5) *Falsimargarita iris* (Smith); (6) *Venustatrochus georgianus* n.g., n.sp.

5. **Falsimargarita iris** (Smith). Two short and very stout cephalic tentacles. Epipodial tentacles seven pairs, very short and stout and of equal size (Fig. D, 5).

Eales (1923, p. 8) described *F. gemma* (Smith) as being similar but with the epipodial tentacles scarcely distinguishable from the lobes of the epipodial fringe.

6. **Margarella expansa** (Sowerby); also *steineni* (Strebel), *bouveti* n.sp., *M.* (*Promargarita*) *tropidophoroides* Strebel and *achilles* (Strebel). All with short and stout cephalic tentacles and four pairs of moderately long epipodal tentacles, which increase in size gradually from the front.

7. **Margarella antarctica** (Lamy). Similar to the typical *Margarella* series listed above except for five instead of four pairs of epipodial tentacles.

Family TROCHIDAE

Subfamily CALLIOSTOMATINAE

Genus **Calliostoma** Swainson, 1840

Type (S.D. Herrmannsen, 1846): *Trochus conulus* Linn.

The Magellanic Calliostomids seem to have more affinity with West American stock than with European typical members. As already mentioned, *Calliostoma* typically has three pairs of long, slender, epipodial tentacles, whereas the Magellanic *modestulum* has four. In the latter, also, the central tooth of the radula is narrow with a deep base and the laterals have the cusps on long slender necks. *C. platinum* Dall, 414 fathoms, California, has four long epipodial tentacles, and *C. annulatus* Martyn, California, has 'goose-necked' laterals. The New Zealand *Venustas cunningham* (G. & P.) has four pairs of short epipodial tentacles, but the central and lateral teeth are more like those of typical *Calliostoma*.

On shell characters the Magellanic *nordenskjoldi*, *modestulum* and *anderssoni* appear respectively to belong to distinct groups, but there is scarcely any difference in dentition between *nordenskjoldi* and *modestulum*.

There is insufficient comparative material available to me properly to evaluate the differences indicated by the dentition, so for the present the Magellanic members are retained in *Calliostoma* (*sensu lato*).

Calliostoma nordenskjoldi Strebel

Calliostoma nordenskjoldi Strebel, 1908, p. 66, pl. 1, figs. 5, 5*a*, *b*.

TYPE LOCALITY. Coast of northern Argentina, 37° 50′ S, 56° 11′ W, 100 m.

St. WS 776. Gulf of St. George, Patagonia, 46° 18′ 15″ S, 65° 02′ 15″ W, 3 Nov. 1931, 107–99 m. (one living example).

DENTITION. Fig. H, 22, p. 190. $(\infty+1)+4+1+4+(1+\infty)$. The central tooth of the radula in the above species, *coppingeri*, *modestulum* and the new genus *Photinastoma*, differ from that of typical *Calliostoma* in having a narrow and deep base. The laterals in this group are elaborately foliated and attached to their bases by slender extensions like 'goose-necks'. The central tooth in *nordenskjoldi* is distinctive, in that although most of the tooth is narrow it suddenly widens at the base.

Calliostoma modestulum Strebel

Calliostoma modestulum Strebel, 1908, p. 70, pl. 1, figs. 13*a*, *b*.
Calliostoma modestulum Melvill & Standen, 1912, p. 347.

TYPE LOCALITY. South of Falkland Is., 52° 29′ S, 60° 36′ W, 197 m.

St. 1321. From 4 miles S 72° W of East Tussac Rock, Cockburn Channel, to 5·6 miles S 75° W of East Tussac Rock, Tierra del Fuego, 16 Mar. 1934, 66 m.
St. WS 72. North of Falkland Is., 51° 07′ S, 57° 34′ W, 5 Mar. 1927, 79 m.
St. WS 80. North-west of Falkland Is., 50° 58′ S, 63° 39′ W to 50° 55′ 30″ S, 63° 36′ W, 14 Mar. 1927, 152-156 m.
St. WS 81. 8 miles N 11° W of North I., West Falkland Is., 19 Mar. 1927, 81–82 m.
St. WS 212. North of Falkland Is., 49° 22′ S, 60° 10′ W, 30 May 1928, 242–249 m.
St. WS 225. North-west of Falkland Is., 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.
St. WS 250. North of Falkland Is., 51° 45′ S, 57° W, 20 July 1928, 251–313 m.
St. WS 750. North-east of Falkland Is., 50° 50′ S, 57° 15′ 13″ W, 18–19 Jan. 1932, 135–144 m.
St. WS 877. Off south-west coast of West Falkland Is., 52° 35·5′ S, 61° 04′ W, 4 Apr. 1932, 350–0 m.

RANGE. From 49° 22′ to 52° 29′ S and 57° 15′ 13″ to about 65° W in 66–350 m. Falklands area to Tierra del Fuego and Patagonia.

DENTITION. Fig. H, 15, p. 190. $(\infty+1)+5+1+5+(1+\infty)$. Central tooth narrow with a deep base, laterals foliated and 'goose-necked'. Innermost marginal massive and hooked with seven strong cusps on its inner distal face and a row of denticles near the outer distal edge.

ANIMAL. Two long, slender cephalic tentacles and eyes at the end of short stalks at the outer base of each tentacle as in typical *Calliostoma*. Four pairs of long, slender, epipodial tentacles.

Calliostoma falklandicum Strebel

Calliostoma falklandicum Strebel, 1908, p. 69, pl. 6, fig. 89*a–d*.

TYPE LOCALITY. Port Albemarle, Falkland Is., 52° 9′ S, 60° 33′ W, 15 m.

St. WS 97. North-west of Falkland Is., 49° S, 62° W to 49° 01′ S, 61° 56′ W, 18 Apr. 1927, 146–145 m.
St. WS 225. North-west of Falkland Is., 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m.
St. WS 237. North of Falkland Is., 46° S, 60° 05′ W, 7 July 1928, 150–256 m.

St. WS 239. North-west of Falkland Is., 51° 10′ S, 62° 10′ W, 15 July 1928, 196–192 m.
St. WS 784. North of Falkland Is., 49° 47′ 45″ S, 61° 05′ W, 5 Dec. 1931, 170–164 m.
St. WS 804. North-west of Falkland Is., 50° 22′ 45″ S, 62° 49′ W, 6 Jan. 1932, 143–150 m.
St. WS 824. Off East Falkland Is., 52° 29′ S, 58° 27′ W, 19 Jan. 1932, 146–137 m.
St. WS 829. North-west of Falkland Is., 50° 51′ S, 63° 13′ 30″ W, 31 Jan. 1932, 155–0 m.
St. WS 854. Off Golfo de San Jorge, Patagonia, 45° 16′ S, 64° 25′ W, 22 Mar. 1932, 97 m.

RANGE. From 45° 16′ to 52° 9′ S and 58° 27′ to 64° 25′ W. in 15-256 m., Falklands area to Golfo de San Jorge, Patagonia.

In addition to the above, Strebel (1908) described a third species, *venustulum*, from Port Albemarle, Falkland Islands, at 40 m.

All three are closely allied and may yet prove to be variations of a single species.

The Discovery material is covered by both *modestulum* and *falklandicum*, but no examples of the stronger sculptured *venustulum* were taken. The chief differences between *modestulum* and *falklandicum* are that the former has a rounded periphery and only subobsolete spirals on the base, whereas the latter is carinated by a peripheral ridge and has several distinct spirals on the inner part of the base, bordering the pillar. The third member of the group, *venustulum*, resembles *falklandicum*, but has granulated spirals on the upper portion of each whorl.

Taking the station lists for both *modestulum* and *falklandicum*, only two stations, WS 80 and WS 225, produced both species, but on the other hand only one or two examples were taken at most of the stations.

The two forms do not indicate obvious bathymetric variation except that *modestulum* alone is represented at the deepest station, 350 m. The range is similar also, except that on the available records *falklandicum* extends farther northwards and *modestulum* farther westwards than the centre of distribution, which appears to be just north of the Falklands.

Calliostoma sp.

Specimens from three Magellanic stations have the shape of *falklandicum* but have three broad spiral bands of pink on the spire whorls. The carina bears a smooth raised spiral ridge, and there are two subsidiary spiral cords on the upper surface of the whorls. They closely resemble Strebel's (1905) figure of *C. nuda roseotincta* and *C. optimum* Rochebrune & Mabille (1889). Compare also *nuda* Philippi, *nuda flavidocarnea*, *irisans* and *kophameli* Strebel, *dozei* Rochebrune & Mabille and *consimilis* Smith.

I am unable to determine satisfactorily the undermentioned material since it does not include adults and there are a number of Magellan species, all very similar as far as one can judge from descriptions and figures.

St. 1321. From 4 miles S 72° W of East Tussac Rock, Cockburn Channel, to 5·6 miles S 75° W of Tussac Rock, Tierra del Fuego, 16 Mar. 1934, 66 m.
St. WS 222. South-east of Point Desire, Patagonia, 48° 23′ S, 65° W, 8 June 1928, 100–106 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.

Calliostoma coppingeri (Smith)

Trochus (Zizyphinus) coppingeri Smith, 1880, p. 320.
Calliostoma coppingeri Dall, 1889*a*, p. 344, pl. 12, fig. 4.

TYPE LOCALITY. Mouth of Rio de la Plata, 28 fathoms, Argentina.

St. WS 852. 44° 12·5′ S, 64° 13′ W, 21 Mar. 1932, 86–88 m.

DENTITION. Fig. H, 18, p. 190.

RANGE. Off Rio de la Plata, 10 fathoms, and off Cape Delgado, 43 fathoms (Dall, 1889).

Genus Venustatrochus n.g.

Type: *V. georgianus* n.sp.

This genus is provided for a benthic species from South Georgia, which on external shell features is not dissimilar from normal deep-water thin-shelled Calliostomids. The dentition, however, is so different from that of typical *Calliostoma*, *Photinula* and the *Photinula*-like Calliostomids of the Magellan Province that generic separation is essential. Normal Calliostomids exhibit a radula with from four to seven laterals and a central tooth with a simple, more or less rectangular base, which is deeper than it is broad. The inner marginal is massive, long and somewhat crooked at the end, and bears on the underside a small number of prominent comb-like denticles. The central and laterals have long and slender curved cusps which are delicately serrated, and it is difficult to imagine how they can be effectively used without suffering damage.

The radula of *Venustatrochus* resembles that of the Calliostomids in the possession of large inner marginals with comb-like cusps and elaborately serrated, slender, curved cusps on the central and laterals. The discordant features are shown in the central tooth, which has a long, very narrow cusp on a large diamond-shaped base, and in the laterals, which are as the central except for being cut away on the inner side of the base. The most remarkable difference is in the number of laterals (sixteen) which is greater than in any other known Trochoid.

Formerly the West Indian *Livonia pica*, which has nine laterals, was quoted as the Trochoid with the largest known number of these teeth (Fig. H, 17). A curious similarity between the radulae of *Venustatrochus* and *Livonia* is that they both have a diamond-shaped base to the central. In *Livonia*, however, the inner marginal is a massive hooked tooth and none of the teeth has the long, slender serrated cusps of the Calliostomids. I do not consider that the resemblances noted between the radulae of *Venustatrochus* and *Livonia* indicate close relationship, and certainly the shell features are discordant in almost every particular.

Venustatrochus georgianus n.sp., Pl. X, fig. 68

Shell large, very thin, conical with biangulate whorls, the lower one coincident with the suture and forming the periphery of the last whorl; imperforate. Colour uniformly pale buff, with a greenish iridescence showing through. Whorls eight (seven in holotype), including the protoconch, which is small but projecting, slightly asymmetrical and consists of one unsculptured whorl somewhat immersed at the tip with a dull, slightly malleated white surface. First two post-nuclear whorls with two spiral threads above the peripheral carina and one below it; third with two above and two below, fourth with six above and three below, fifth with twelve above and ten below, penultimate with seventeen above and sixteen below, and base with about forty threads. The suture is ledged by the uppermost thread, and immediately below this on the later whorls there is a smooth, very slight concavity. The upper surface of the whorls is crossed by retractively arcuate fine dense threads which render the spirals minutely granular, but the basal spirals are smooth. Pillar plain, arcuate, much thickened above and with a spreading callus which completely fills the umbilical area. Interior of aperture iridescent and delicately spirally grooved. Outer lip thin and sharp. Operculum horny, circular, multispiral, reddish brown.

Diameter 40·0 mm.; height 40·0 mm. (paratype).

Diameter 32·0 mm.; height 30·5 mm. (holotype).

The smaller specimen is selected for the holotype, since the other has the protoconch missing and the surface is eroded and encrusted.

The species resembles in a general way Dall's *Calliostoma platinum* (1889*a*, p. 343, pl. VII, fig. 2) from

near Santa Barbara Islands, 414 fathoms, California. Since the radula of *platinum* has not been described, actual relationship with *georgianus* cannot be claimed.

TYPE LOCALITY. St. 42. Off mouth of Cumberland Bay, South Georgia, from 6·3 miles N 89° E of Jason Lt. to 4 miles N 39° E of Jason Lt., 1 Apr. 1926, 120–204 m.

DENTITION. Fig. H, 16, p. 190. $(\infty+1)+16+1+16+(1+\infty)$.

Falsimargarita n.gen.

Type: *Margarites gemma* Smith

Eales (1923, p. 8) gave a good description and figure of the dentition of *gemma*. This and the allied species *iris* have the radula of the Calliostomid type, that is, with more or less rectangular-based central and lateral teeth having long curved foliaceous cusps bearing numerous sharp denticles.

The shell is very thin, white or pale cream, iridescent both externally and internally, elaborately sculptured with fine crisp spirals and axial threads and with a deep but relatively narrow umbilicus.

This new genus differs from *Calliostoma* in the thin externally iridescent shell, open umbilicus and in details of the radula. The broad central tooth, more than twice the width of any of the laterals, is a distinctive feature. There is, of course, no relationship to *Margarita*.

Falsimargarita gemma (Smith)

Margarites gemma Smith, 1915, p. 62, pl. 1, fig. 1.
Margarites gemma Eales, 1923, pt. 5, p. 8.

DENTITION. Fig. H, 23, p. 190.

TYPE LOCALITY. Off Oates Land, 180–200 fathoms.

St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.

Major diameter 22·0 mm.; minimum diameter 19·0 mm.; height 18 mm. (holotype).

Major diameter 17·4 mm.; minimum diameter 15·0 mm.; height 15 mm. (St. 175).

The finding of this superb and rare species on the opposite side of Antarctica from the type locality is of interest.

The Bransfield Strait specimen agrees in minute detail with Smith's full description and excellent figure, and the radula is exactly as figured by Eales (1923, loc. cit.). The specimen is not quite fully grown.

Falsimargarita iris (Smith)

Margarites iris Smith, 1915, p. 91, pl. 2, fig. 4.
Margarites iris Eales, 1923, p. 7.

TYPE LOCALITY. West of Falkland Is., 125 fathoms.

St. WS 245. Between Falkland Is. and Patagonia, 52° 36′ S, 63° 40′ W, 18 July 1928, 304–290 m.
St. WS 818. Between Falkland Is. and Patagonia, 52° 31′ 15″ S, 63° 25′ W, 17 Jan. 1932, 272–278 m.
St. WS 821. Off Falkland Is., 52° 55′ 45″ S, 60° 55′ 00″ W, 18 Jan. 1932, 461–468 m.

Genus Photinula H. & A. Adams, 1854

Type (s.d. Pilsbry 1889), *Margarita coerulescens* King & Broderip

Thiele has shown by his work on Trochoid dentition that *Photinula* is allied to *Calliostoma* (Thiele, 1906*c*, pp. 12–15 and 1921, p. 68).

Photinula coerulescens (King & Broderip)

Margarita coerulescens King & Broderip, 1831, p. 346, fig. 54.
Photinula ringei Pfeffer, 1887, p. 133.
Photinula coerulescens Rochebrune & Mabille, 1889, p. H81.

Photinula coerulescens Pilsbry, 1889, p. 278, pl. 44, figs. 18, 19.
Photinula coerulescens Strebel, 1905, p. 140, pl. 5, figs. 25*a*, *b*, 27*a*, *b* and 30.
Photinula coerulescens Strebel, 1908, p. 71, pl. 6, fig. 93*a*, *b*.
Photinula taeniata coerulescens Melvill & Standen, 1914, p. 116.

DENTITION. Fig. H, 24, 190.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., 4 May 1926, 115 m.
St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 1½ cables N 50° E of Sparrow Point, 16 May 1926, 10½–16 m.
St. 1230. 6·7 miles N 62° W from Dungeness Lt., Magellan Strait, 23 Dec. 1933, 27 m.
St. WS 79. Between Falkland Is. and Patagonia, 51° 01′ 30″ S, 64° 59′ 30″ W, 13 Mar. 1927, 132–131 m.
St. WS 80. Between Falkland Is. and Patagonia, 50° 57′ S, 63° 37′ 30″ W, 14 Mar. 1927, 152–156 m.
St. WS 217. North-north-west of Falkland Is., 47° 06′ S, 62° 12′ W, 3 June 1928, 116–114 m.
St. WS 764. Between Falkland Is. and Argentina, 44° 38′ 15″ S, 61° 58′ 30″ W, 17 Oct. 1931, 110–104 m.
St. WS 775. Between Falkland Is. and Argentina, 46° 44′ 45″ S, 63° 33′ W, 2 Nov. 1931, 115 m.
St. WS 782. North of Falkland Is., 50° 29′ 15″ S, 58° 23′ 45″ W, 4 Dec. 1931, 141–146 m.
St. WS 816. Between Falkland Is. and Patagonia, 52° 09′ 45″ S, 64° 56′ W, 14 Jan. 1932, 150 m.
St. WS 817. Between Falkland Is. and Patagonia, 52° 23′ S, 64° 19′ W, 14 Jan. 1932, 191–202 m.
St. WS 834. Off Santa Cruz, Patagonia, 50° 18′ 45″ S, 67° 44′ W, 9 Feb. 1932, 27–38 m.
St. WS 836. Off Patagonia, 53° 05′ 30″ S, 67° 38′ W, 3 Feb. 1932, 64 m.
St. WS 854. Off Patagonia, 45° 16′ S, 64° 25′ W, 22 Mar. 1932, 97 m.
St. WS 869. Between Falkland Is. and Patagonia, 52° 15′ 30″ S, 64° 13′ 45″ W, 31 Mar. 1932, 187–0 m.

RANGE. Southern Argentina to Tierra del Fuego and Falkland Is., 0–202 m.

A handsome, depressed, smooth, pale, opalescent shell with a few conspicuous heavy spiral bands of purplish brown to dark blue, often with subsidary spirals of green and grey.

Genus **Photinastoma** n.g.

Type: *Trochus taeniatus* Wood

The Falkland Islands *taeniatus* is very similar in appearance to the genotype of *Photinula*, but study of the radula and epipodial characters shows that although they are both derivatives from Calliostomid stock they are sufficiently distinct from each other to warrant generic separation. That *taeniatus* is not a typical *Photinula* has been pointed out already by Dall (1889*a*, p. 344), who wrote: 'This species is referred to *Photinula* by H. & A. Adams, but appears to be simply a smooth *Calliostoma*. There is no umbilical callus as in *Photinula coerulescens*...', etc., and by Strebel (1908, p. 71), who segregated it from *Photinula* s.str. under 'Gruppe *Calliostoma-Photinula* Strebel'. This hyphenated combination has been cited as of nomenclatural status by Neave (1939, p. 535), but it seems very clearly indicated that Strebel did not intend this. The manner of presentation of subgenera in this same work of Strebel's proves this, i.e. p. 74 'Gruppe *Promargarita* n.subg.' The question remains, that notwithstanding Strebel's intention, does the entry fulfil the then existing requirements for a new name? The mere hyphenating, without alteration, of two valid generic names, is apparently not covered by the rules, and in my opinion does not amount to the proposition of a new genus or subgenus.

Study of the dentition and epipodial fringe in *taeniatus* and *coerulescens* confirms that although they compare in a general way with *Calliostoma* there are sufficient differences between them to warrant separation.

In *Photinastoma taeniata* the radula is almost identical with that of the Magellan Calliostomids. Also it has four epipodial tentacles as in certain Californian and New Zealand Calliostomids, but not as in the English genotype, which has three. Features of the *taeniata* radula, which are common to the Magellan

Calliostomids, and to the species *Calliostoma annulata* from California but not to the genotype of *Calliostoma*, are the very deep, narrow-based central tooth and the long 'goose-necked' cusps on the laterals.

In *Photinula coerulescens* the laterals are not so conspicuously 'goose-necked' and the central is broad and shallow-based, more nearly approaching the typical Calliostomid radula. The epipodial tentacles, however, are six, and there is a distinct but small veil covering the top of each cephalic tentacle at its base.

Photinastoma taeniata (Wood)

Trochus taeniatus Wood, 1828, pl. 5, fig. 12.
Photinula taeniata H. & A. Adams, 1858, p. 427.
Photinula taeniata Pilsbry, 1889, p. 278, pl. 44, figs. 18, 19.
Photinula taeniata Rochebrune & Mabille, 1889, p. 1187.
Photinula taeniata v. Ihering, 1902, p. 101.
Photinula taeniata Strebel, 1905, p. 135, pl. 5, figs. 28*a*, *b*, 29.
Photinula taeniata var. elata Strebel, 1905, p. 138, pl. 5, fig. 28*c*.
Photinula taeniata Melvill & Standen, 1907, p. 98.
Photinula taeniata Strebel, 1908, p. 71.
Photinula taeniata Melvill & Standen, 1914, p. 116.

DENTITION. Fig. H, 25, p. 190.

TYPE LOCALITY. Unknown. Port Stanley, Falkland Is., here designated.

St. 52. Port William, East Falkland Is., 7·4 cables N 17° E of Navy Point, 5 May 1926, 17 m.
St. 53. Port Stanley, East Falkland Is. (hulk of 'Great Britain'), 12 May 1926, 0–2 m.
St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 1½ cables N 50° E of Sparrow Point, 16 May 1926, 10½–16 m.
St. WS 834. Off Coy Inlet, Santa Cruz, Patagonia, 52° 57′ 45″ S, 68° 08′ 15″ W, 2 Feb. 1932, 27–38 m.
St. WS 847. Off Santa Cruz, Patagonia, 50° 18′ 45″ S. 67° 44′ 00″ W, 9 Feb. 1932, 56–84 m.

RANGE. Strait of Magellan (Pilsbry, 1889), Patagonia ('Discovery') and Falkland Is. (Strebel, 1905; Melvill & Standen, 1907; 'Discovery'), 0–84 m.

A handsome species with red spiral lines on a smooth pearly white surface.

Photinastoma taeniata nivea (Cooper & Preston)

Photinula taeniata var. *nivea* Cooper & Preston, 1910, p. 112.

TYPE LOCALITY. Falkland Is.

St. 51. Off Eddystone Rock, East Falkland Is., 4 May 1926, 115 m.

This seems to be something more than an albinistic form of *taeniata*. Paratypes, together with the St. 51 material, show the following features not common to *taeniata* typical: no traces of colour pattern, subobsolete spirally incised lines, and a taller spire with more globose whorls. Both species and subspecies have three strong spiral cords on the first post-nuclear whorl. Unfortunately, only empty shells are available.

Subfamily STOMATELLINAE

Genus **Margarella** Thiele, 1893

n.nom. for *Margaritella* Thiele, 1891 *non* Meek & Hayden, 1860

Type (o.d.?): *Margarita violacea* King

Margarella expansa (Sowerby)

Margarita expansa Sowerby, 1838, p. 24.
Margarita expansa Sowerby, 1841, figs. 16, 17.
Photinula expansa H. & A. Adams, 1858, pp. 427–8.
Trochus (*Photinula*) *expansus* E. A. Smith, 1879, p. 167.

Photinula expansa Pilsbry, 1889, p. 279, pl. 39, figs. 51, 52.
Photinula expansa V. Ihering, 1902, p. 99.
Photinula expansa Smith, 1902, p. 207.
Photinula expansa Strebel, 1905, p. 152, pl. 5, figs. 9–11, 14, 15.
Photinula expansa Melvill & Standen, 1907, p. 98.
Photinula (Margarella) expansa Strebel, 1908, p. 72, pl. 5, fig. 68.
Margarella expansa Thiele, 1912, p. 234.

TYPE LOCALITY. Falkland Is.

St. 51. Off Eddystone Rock, East Falkland Is., 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.
St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 16 May 1926, 10½–16 m.
St. 58. Port Stanley, East Falkland Is., 19 May 1926, 1–2 m.
St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 25 Mar. 1927, 79 m.

Margarella violacea (King)

Margarita violacea King & Broderip, 1830–31, p. 346.
Margarita persica Gould, 1852, p. 192.
Photinula almyris Rochebrune & Mabille, 1885, p. 108.
Photinula halmyris Rochebrúne & Mabille, 1889, p. 89, pl. 4, fig. 6.
Photinula violacea Rochebrune & Mabille, 1889 p. 87.
Photinula violacea V. Ihering, 1902, p. 98.
Photinula violacea Strebel, 1905, p. 145, pl. 5, fig. 1–8, 12, 13.
Photinula violacea Smith, 1905, p. 336.
Photinula violacea Melvill & Standen, 1907, p. 99.
Photinula (Margarella) violacea Strebel, 1908, p. 72.

TYPE LOCALITY. Strait of Magellan.

St. 56. Sparrow Cove, Port William, East Falkland Is., 16 May 1926. 10½–16 m.
St. 724. Fortescue Bay, Magellan Strait, 16 Nov. 1931, 0–5 m. on kelp.
St. 1321. From 4 miles S 72° W of East Tussac Rock, Cockburn Channel, Tierra del Fuego, to 5·6 miles S 75° W of East Tussac Rock, 16 Mar. 1934, 66 m.
St. WS 71. 6 miles N 60° E of Cape Pembroke Lt., East Falkland Is., 23 Feb. 1927, 82–80 m.
St. WS 80. North-west of Falkland Is., 50° 57′ S, 63° 37′ 30″ W, 14 Mar. 1927, 152–156 m.
St. WS 88. North of Le Maire Strait, Patagonia, 54° 00′ S, 64° 57′ 30″ W, 6 April 1927, 118 m.
St. WS 824. Off south-east of Falkland Is., 52° 29′ S, 58° 27′ W, 19 Jan. 1932, 146–137 m.
St. WS 825. Off north-east of Falkland Is., 50° 50′ S, 57° 15′ 13″ W, 19 Jan. 1932, 135–144 m.
St. WS 829. Between Falkland Is. and Patagonia, 50° 51′ S, 63° 13′ 30″ W, 31 Jan. 1932, 155 m.
St. WS 836. Off Patagonia, 53° 05′ 30″ S, 67° 38′ W, 3 Feb. 1932, 64 m.
St. WS 838. Between Falklands Is. and Patagonia, 53° 11′ 45″ S, 65° 00′ W, 5 Feb. 1932, 148 m.
St. WS Shore collecting. Ringdove Inlet, Wide Channel, 7 May 1931.

RANGE. Magellan Province: Patagonia and Tierra del Fuego (Rochebrune & Mabille, 1885; Strebel, 1905, 1908; 'Discovery'); Falkland Is. (Melvill & Standen, 1907; 'Discovery').

It is often difficult to distinguish between *violacea* and pinkish forms of *expansa*. Typical *expansa* is olivaceous, with a bright green iridescence showing through on the upper whorls, and it has a relatively large ovate aperture. In *violacea* the coloration is constantly pink, the form is more conical, the whorls more tightly coiled, and in consequence the aperture is smaller and approximately circular. Both species have the columellar callus deeply excavated in the middle. Examples from deep water (Sts. WS 824, WS 829 and WS 838) are pure white.

I have not seen *Photinula solidula* Cooper & Preston (1910, p. 111, pl. 4, fig. 3), Falkland Islands, which is most likely a synonym of *violacea*.

Margarella steineni (Strebel)

Margarita (Photinula) expansa Martens & Pfeffer (*non* Sowerby), 1886, pl. 2, figs. 10*a*, *c*.
Photinula steineni Strebel, 1905, p. 158, pl. 5, figs. 16*a–d*.
Photinula steineni Strebel, 1908, p. 73.
Margarella steineni L. David, 1934, p. 127.

TYPE LOCALITY. South Georgia.

St. 141. East Cumberland Bay, South Georgia, 200 yards from shore, 29 Dec. 1926, 17–27 m.
St. 145. Stromness Harbour, South Georgia, 7 Jan. 1927, 26–35 m.
St. WS 25. Undine Harbour (North), South Georgia, 17 Dec. 1926, 18–27 m.

RANGE. South Georgia, 0–35 m.

A small, pale cream-coloured shell, pearly externally, and greenish iridescent inside the aperture.

Margarella jason n.sp., Pl. V, fig. 1

A pale cream, pearly shell with pale iridescent interior to the aperture. Whorls four, rapidly increasing. Spire half height of aperture, suture plain, tangential to slightly adpressed over last half-whorl. Columella lip broad, slightly concave, rapidly contracted below to the thin-edged basal outer lip. Outer edge of columellar callus sharp, outwardly curved and partly encroaching upon a crescentic umbilicus, which is incised with four concentric narrow grooves. Operculum normal, horny, with a central nucleus.

This new species resembles *antarctica* (Lamy, 1905), but differs in reaching only half the linear dimensions, in having a much smaller umbilicus, incised with grooves, a broadly expanded columellar callus and more rapidly increasing whorls. Both species have the whorls rather narrowly rounded at the periphery.

Major diameter 6·0 mm.; minimum diameter 5·0 mm.; height 4·5 mm. (holotype).

TYPE LOCALITY. St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238-270 m.

This species is almost certainly a benthic relative of Strebel's *Margarita subantarctica* (1908, p. 76). Strebel's species is based upon juveniles (1·4 × 1·2 mm.) from low water, Cumberland Bay, South Georgia. The smooth unicoloured *Margarella* forms are difficult enough to separate even as adults. It is possible that when fully grown littoral shells are found, my *jason* n.sp. may prove to be a synonym of *subantarctica*, but, on the other hand, it is unlikely that shells from such different habitats will be identical. Thiele (1912, p. 258) included *subantarctica* in the synonymy of *antarctica*. For the present Strebel's species is best considered indeterminate.

Margarella bouvetia n.sp., Pl. V, fig. 3

Shell small, white, with a faint iridescence. Turbinate, thin, of $4\frac{1}{2}$ rounded whorls. Spire three-fifths height of aperture. Suture impressed, not margined. Columellar callus moderately wide medially, rapidly contracted below to the thin-edged basal outer lip, and above, partly bridging a deep open umbilicus. Umbilicus about one-tenth major diameter of shell, sculptured between the outer area of the umbilicus and the base with nine deeply incised spiral grooves. Eight of these grooves are closely spaced, but the outermost is double-spaced. The rest of the shell is smooth, except for weak, distant, irregular, axial growth lines which become concentrated within the umbilicus. Operculum horny with a central nucleus.

DENTITION. Fig. G, 8, p. 189.

Major diameter 8·4 mm.; minimum diameter 7·0 mm.; height 7·5 mm. (holotype).

Major diameter 9·0 mm.; minimum diameter 7·8 mm.; height 8·0 mm. (largest).

TYPE LOCALITY. St. 456. 1 mile east of Bouvet I. 18 Oct. 1930, 40–45 m.

The species resembles *M. refulgens* Smith (1907) (*Valvatella*), from McMurdo Sound, 10–130 fathoms. Smith's species, however, is much smaller (5 × 5 mm.) and lacks the spiral grooves surrounding the umbilicus.

Margarella porcellana n.sp., Pl. V, fig. 2

Shell small, uniformly white, polished and faintly iridescent within the aperture. Whorls $4\frac{1}{2}$, relatively slowly increasing, broadly convex above and more narrowly convex at lower third of whorl height. Spire five-sixths the height of the aperture. Suture adpressed throughout, giving the appearance of a narrow submargining. Columellar callus broad with a sharply defined edge, concave and completely covering the umbilical area. The species is close to *steineni*, but differs in having a higher spire and adpressed false-margined sutures. Also, it lacks the pearly appearance of the exterior and the intense iridescence of the interior, which features are so characteristic of *steineni*.

Major diameter 8·0 mm.; minimum diameter 7·0 mm.; height 7 mm. (holotype).

Major diameter 8·5 mm.; minimum diameter 6·7 mm.; height 6·5 mm. (*steineni*, St. 145).

Type locality.

St. 1562. Off Marion I., 46° 51·7′ S, 37° 56·5′ E to 46° 54·8′ S, 37° 53·8′ E, 7 Apr. 1935, 97–104 m.
St. 1564. Off Marion I., 46° 36·5′ S, 38° 02·3′ E, 7 Apr. 1935, 108-113 m.
St. 1563. Off Marion I., 46° 48·4′ S, 37° 49·2′ E, 7 Apr. 1935, 113–99 m.

Margarella antarctica (Lamy)

Margarita antarctica Lamy, 1905, p. 481.
Margarita antarctica Lamy, 1907, p. 9, pl. 1, figs. 2, 3, 4.
Valvatella antarctica Melvill & Standen, 1907, p. 99.
Valvatella antarctica Lamy, 1911 *a*, p. 13.

Dentition. Fig. G, 9, p. 189.

Type locality. South Orkney Is.

St. 164. East end of Normanna Strait, South Orkneys, near Cape Hansen, Coronation Is., 18 Feb. 1927, 24–36 m.
St. 179. Melchior I., Schollaert Channel, Palmer Archipelago, 10 Mar. 1927, 4–10 m.
St. 1486. Harmony Cove, Nelson I., South Shetlands, 3 Jan. 1935, shore coll.
Wilhelmina Bay, Danco Land, South Shetlands, 64° 30′ S, 62° W, 1–8 fathoms (A. G. Bennett).

Range. Palmer Archipelago ('Discovery'), Wandel I. and Moureau I. (Thiele, 1912), Petermann I. (Lamy, 1911), South Orkneys (Lamy, 1905) and South Shetlands ('Discovery').

Subgenus **Promargarita** Strebel, 1908

Type (monotypy): *Promargarita tropidophoroides* Strebel

The genotype appears strikingly different from typical *Margarella* which has a smooth surface and rounded whorls. Strebel's *Promargarita tropidophoroides* is biangulated by two heavy spiral keels, and the entire surface is deeply incised with closely spaced spiral grooves. It is pointed out below, however, that *achilles* Strebel has incised spiral sculpture both on the early whorls and surrounding the umbilical area, but the rest of the shell is smooth. My new subspecies *obsoleta* has uniformly developed incised spirals over the whole shell, but it is only weakly biangulate as also is *achilles*. All three are uniformly brownish except for a white zone around the umbilical area and one or two narrow white bands in place of the keels where these have been reduced to subangles.

The radulae of both *tropidophoroides* and *achilles* show no essential differences from that of *Margarella*.

Strebel's *Promargarita* is retained as a subgenus, since it expresses a localized spirally sculptured trend in a genus that normally has smooth polished shells.

Margarella (Promargarita) tropidophoroides (Strebel)

Promargarita tropidophoroides Strebel, 1908, p. 74, pl. 5, fig. 73*a–d*.
Promargarita tropidophoroides Thiele, 1912, pl. 15, fig. 17 (radula).
Margarella (*Promargarita*) *tropidophoroides* L. David, 1934, p. 127.

DENTITION. Fig. G, 4, p. 189.

TYPE LOCALITY. South Georgia, 20 m.

St. 1941. Leith Harbour, South Georgia, 29 Dec. 1936, 55–22 m.
St. MS 6. East Cumberland Bay, ¼ mile south of Hope Point to 1¼ cables S×E of King Edward Lt., South Georgia, 12 Feb. 1925, 24–30 m.
St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, South Georgia, 14 Feb. 1925, 26–18 m.
St. MS 67. East Cumberland Bay, 3 cables north-east of Hobart Rock to ½ cable west of Hope Point, South Georgia, 28 Feb. 1926, 38 m.
St. WS 25. Undine Harbour (North), South Georgia, 17 Dec. 1926, 18–27 m.

Major diameter 14·2 mm.; minimum diameter 11·5 mm.; height 11·7 mm. (St. MS 67).
Major diameter 17·5 mm.; minimum diameter 14·5 mm.; height 14·0 mm. (St. MS 10).

Margarella (Promargarita) tropidophoroides obsoleta n.subsp., Pl. V, fig. 4

This is a form of *tropidophoroides* with the spiral keels reduced to a weak biangulation.

Shell thin, depressed-turbinate, very weakly biangulate, imperforate, pale yellowish brown with a white zone surrounding the umbilical area and occasionally a narrow white band at the lower sub-angle. Spire half height of aperture. Uniformly sculptured with numerous deeply incised spiral lines. Whorls five, broadly rounded, but weakly angulate above the middle on the spire-whorls, and at the periphery. The spirals number seven on the first post-nuclear whorl, fifteen to twenty on the penultimate and about forty-five on the body-whorl. The columellar callus is white, broad, concave and completely fills the umbilical area. Compared with *achilles* of similar size, *obsoleta* has a taller spire, a more rounded aperture, is of lighter colour and has evenly developed spirals over the whole shell.

Major diameter 13·5 mm.; minimum diameter 11·0 mm.; height 11·0 mm. (St. MS 6).

TYPE LOCALITY. St. MS 6. East Cumberland Bay, ¼ mile south of Hope Point to 1¼ cables S×E of King Edward Point Lt., South Georgia, 12 Feb. 1925, 24–30 m.

Margarella (Promargarita) achilles (Strebel)

Photinula achilles Strebel, 1908, p. 73, pl. 5, fig. 69*a*, *b*.

TYPE LOCALITY. South Georgia, 1–2 m.

St. 145. Stromness Harbour, South Georgia, between Grass I. and Tonsberg Point, 7 Jan. 1927, 26–35 m.
St. MS 6. East Cumberland Bay, ¼ mile south of Hope Point to 1¼ cables S×E of King Edward Point Lt., South Georgia, 12 Feb. 1925, 24–30 m.
St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.

This is a large, thin-shelled species, depressed-turbinate, with a relatively large ovate aperture. It is light reddish brown with a broad zone of white surrounding the umbilical area, occasionally a narrow white band just below the periphery and rarely a second narrow white band above the periphery. The body-whorl is weakly biangulate. Sculpture consisting of incised lines, clearly shown on the early whorls and around the umbilical area, but obsolete elsewhere. In the adult there are about eight lirations on the early whorls and six or seven around the umbilical area. The umbilicus is completely covered by a broad concave white columellar callus. Strebel compares this species with *expansa*, but the relationship is certainly with *Promargarita tropidophoroides*.

Major diameter 19·0 mm.; minimum diameter 16·2 mm.; height 16·5 mm. (St. WS 25).

DENTITION. The radula is scarcely distinguishable from that of *tropidophoroides*.

Genus Submargarita Strebel, 1908

Type (monotypy): *Submargarita impervia* Strebel

Submargarita impervia Strebel

Submargarita impervia Strebel, 1908, p. 75, pl. 5, fig. 71*a–c*.
Submargarita impervia Thiele, 1912, p. 188, pl. 15, fig. 18 (radula).

DENTITION. Fig. G, 10, p. 189.

TYPE LOCALITY. Cumberland Bay, 252–310 m., South Georgia.

St. 27. West Cumberland Bay, 3·3 miles 44 E of Jason Lt., South Georgia, 15 Mar. 1926, 110 m. (one example).

Genus Antimargarita n.g.

Type: *Valvatella dulcis* Smith

This is provided for thin-shelled, colourless, elaborately sculptured depressed-turbinate species with a wide, deep, steep-sided umbilicus. The dentition (Eales, 1923, p. 7, fig. 4) resembles that of *Margarita* in the evenly arcuate sweep of the laterals and central, but individually these teeth are of very different shape.

The simple coiled shells of the Trochoids mask a diversity of internal structures in an ancient and primitive group. Thiele (1921, p. 68) has shown this in his valuable researches on the dentition.

On shells alone there would be every excuse for classing together such species as *Valvatella dulcis* Smith, *Margarita gemma* Smith and *Solariella kempi* n.sp. All three are thin-shelled, umbilicated, and elaborately sculptured with crisp spiral ridges and axial threads, but the dentition clearly indicates that not only are three genera required for their reception, but also they fall individually into three distinct subfamilies of the Trochacea.

The genus probably includes *Submargarita smithiana* Hedley (1916, p. 38, Pl. 5, fig. 58) from off Shackleton Ice-shelf, 65° 20′ S, 95° 27′ E, in 240 fathoms, and *Minolia thielei* Hedley (loc. cit.) from near Shackleton Ice-shelf, 64° 32′ S, 97° 20′ E in 110 fathoms.

Antimargarita dulcis (Smith)

Valvatella dulcis Smith, 1907, p. 10, pl. 11, fig. 8.
Margarites dulcis Thiele, 1912, p. 190, pl. 11, fig. 21.
Margarites dulcis Smith, 1915, p. 63.
Minolia dulcis Hedley, 1916, p. 38.
Margarites dulcis Eales, 1923, p. 6.

TYPE LOCALITY. Discovery Winter Quarters, McMurdo Sound, 77° 50′ 50″ S, 166° 44′ 45″ E, 130 fathoms.

St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

DENTITION. Fig. G, 5, p. 189 (after Eales, 1923).

RANGE. Ross Sea ('Discovery'), Adelie Land (Smith, 1907, 1915), Gauss Station (Thiele, 1912), South Shetlands ('Discovery'), 130–400 fathoms. The 'Discovery' records extend the range of this species to three-fourths of the circumference of Antarctica.

Antimargarita thielei (Hedley)

1916. *Minolia thielei* Hedley, *Aust. Antarct. Exped.* (ser. C), IV (1), Moll. p. 39, pl. 5, fig. 59.

TYPE LOCALITY. Near the Shackleton Ice-shelf, 64° 32′ S, 97° 20′ E, 110 fathoms.

St. 1652. Ross Sea. 75° 56′ 2″ S, 178° 35′ 5″ W, 23 Jan. 1936, 567 m.

The largest example from St. 1652 has $3\frac{1}{2}$ whorls and is 3·8 mm. in diameter by 3·4 mm. in height. The type has four whorls and measures 8 × 7 mm.

Genus Tropidomarga n.g.

Type: *Tropidomarga biangulata* n.sp.

The type of this new genus bears a superficial resemblance to *Minolia*, but the dentition shows close alliance with the boreal '*Pupillaria*' *cinerea* (Couthouy). Both differ from all other *Margarites*-like species (of which the dentition is known to me) in the form of the basal plates of the central and laterals. The central has a large circular base, and the laterals are similar except that they are cut away on the inner side.

The type of *Pupillaria* (*Trochus pupillus* Gould, California) is tall, conical, solid, angulate at the periphery, narrowly umbilicate and sculptured with narrow spiral cords. The species *cinerea* (boreal) is relatively large and thin with a rounded periphery, surface sculptured with narrow, distinct, sharply raised spiral cords and has a deep narrowly open umbilicus about one-eight the major diameter of the base.

The type of *Margarites* (*Helix margarita* Montagu = *Turbo helicinus* Phipps) is depressed turbinate, umbilicate and smooth surfaced.

Although there is apparently a relationship between the antarctic *Tropidomarga* and the boreal *cinerea*, the latter does not conform to the genotypes of either *Margarites* or *Pupillaria*, or any other available genus.

For the antarctic species described below, I propose therefore the new generic name *Tropidomarga*. This new genus has a conical shell with strongly shouldered spire whorls and a prominently bi-angulate body-whorl. The surface is sculptured with thin spiral lirations crossed by finer dense axial threads. At the suture the axials are thickened to form a crenulated submargining. The umbilicus is deep with straight-sided walls and has a width of about one-fifth that of the major diameter of the shell.

Tropidomarga biangulata n.sp., Pl. V, fig. 5

Shell of moderate size, depressed-conical, with prominently shouldered spire-whorls and biangulate body-whorl, broadly umbilicated and sculptured with numerous spiral lirations crossed by dense retractive axial threads. Whorls six, including a low rounded protoconch of one smooth whorl. First post-nuclear whorl with two spiral lirae, second with six, body-whorl with twelve lirations between the suture and upper angulation, nine between the upper and lower angulations (about fifteen, angulations included) and about thirty on the base. They continue just over the edge of the umbilicus, but the remainder of the surface of the walls of the steep-sided umbilicus is plain. Umbilicus about one-fifth major diameter of the base. The suture is delicately crenulated by the axial threads. The angulations are broadly rounded and do not interrupt the sculpture.

Aperture rhomboidal, outer lip thin, strongly retractive in profile, inner lip inclined but moderately straight, slightly thickened medially and slightly encroaching upon the umbilicus, where it curves above and finally spreads as a very thin nacreous glaze over the parietal wall. This glaze is so thin that it does not obliterate the spiral sculpture. Colour buff to very light brown above, creamy white on the base and iridescent within the aperture. Operculum horny, thin, yellowish brown, circular and multispiral.

The biangulate whorls give the species a superficial resemblance to Strebel's *Promargarita tropidophoroides*.

Diameter 14·6 mm.; height 13·0 mm. (holotype).

Diameter 14·0 mm.; height 12·5 mm. (paratype).

TYPE LOCALITY. St. 159. North-east of Cumberland Bay, South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.

DENTITION. Fig. G, 6, p. 189. $\infty + 4 + 1 + 4 + \infty$. Very similar to that of '*Margarita striata*' = *Pupillaria cinerea* Couth (Thiele, 1891, pl. 25, fig. 9) from Gulf of St Lawrence. Both have the central tooth with a circular base and laterals of the same form except that each is cut away on its inner side.

Thiele's drawing of the radula of '*striata*' shows a vestigial fifth lateral and a very weak innermost marginal. In *biangulata* there is no trace of a fifth lateral, and the innermost marginal is the largest of that series, but it is not disproportionately large as in the Calliostomids.

ANIMAL. There are six pairs of epipodial tentacles—the sixth from the front long and slender, almost twice the length of the other five, which are of approximately equal size. Cephalic tentacles moderately long, blunt and flattened. Eye at the end of a short stalk, lying at the outer side of the base of each tentacle. The stalk is confluent with a short veil which crosses the base of a tentacle but does not join up with its opposite member across the head. Head narrow in front and produced into a wrinkled proboscis, with a frilled edge. Epipodial fringe continued to the area in front of the head in an elaborate series of folds.

Subfamily SOLARIELLINAE n.subfam.

This new subfamily is provided for the group of genera *Solariella*, *Machaeroplax* and *Cidarina*. The shells are conical, openly umbilicated, with a more or less circular simple aperture, and sculpture of spiral keels or ribs, usually crenulated or granulated below the suture and bordering the umbilicus.

The radula has an approximate formula of $10+5+1+5+10$, the most distinctive feature being the small number of marginals. In all other Trochoid groups the marginals are so numerous and crowded that it is impossible to determine their exact number. Other distinctive radular features are the very pronounced dip to the centre of each row and the elongate shape of the two outer laterals which resemble the enlarged functional inner marginals of the Calliostomids.

Genus **Solariella** Searles Wood, 1842

Type (monotypy): *Solariella maculata* S. Wood

The genotype is from the English Pliocene and is a heavily carinated shell with prominent beading or crenulations both at the suture and on a ridge bounding the wide funnel-shaped umbilicus.

There is a group of subantarctic species, *Trochus* (*Margarita*) *brychius* Watson, from 900 miles south-east of Kerguelen Island in 900 fathoms, *T.* (*Margarita*) *charopus* Watson from off Kerguelen Island in 105 fathoms, var. *caeruleus* Watson from off Heard Island in 175 fathoms and the new species *kempi* described below. These have the general features of *Solariella*, but lack the sutural and umbilical crenulations.

The radula of *kempi* n.sp., however, is essentially similar to that of *varicosa* Mighels & Adams from Newfoundland to Nova Zembla as figured by Pilsbry (1889, pl. 50, fig. 17) and *biradiatula* Martens from Dar-es-Salam in 400 m. as figured by Martens & Thiele (1903, pl. 8, fig. 37; see Text-fig. G, 12). Both these species have crenulations, but the other shell characters are not very similar, neither are they to the Pliocene genotype nor to the subantarctic group mentioned above. This subantarctic group is for the present retained in *Solariella* pending a revision of the members of the subfamily.

Solariella kempi n.sp., Pl. I, fig. 6

Shell globosely conoidal, thin, sculptured with closely spaced, sharply raised, narrow, spiral cords and dense axial interstitial threads; widely umbilicate. Whorls $5\frac{3}{4}$, regularly increasing and including a minute apparently smooth helicoid protoconch of one whorl. First post-nuclear whorl with three wide-spaced, narrow, sharply raised, spiral cords, second with four, increasing to fifteen on the penultimate, by the addition of intermediate cords, and about sixty on the body whorl from the suture to the edge of the umbilical cavity; about thirty within the umbilicus. The whole surface is crowded with

fine, crisp, retractively oblique radial threads which cross the spiral cords, rendering them minutely gemmate. Whorls strongly convex, slightly flattened below the suture on the early whorls, but resolving into a slight subsutural concavity over the last whorl. Suture impressed to adpressed. Spire equal to height of aperture. Umbilicus wide, perspective outwardly, one-third major diameter of the base but rapidly contracted within to one-ninth the diameter of the base. Aperture circular, discontinuous, outer lip thin; columellar lip slightly thickened and reflexed; parietal wall with a very thin glaze that does not obscure the sculpture. Colour pale pinkish buff, interior of the aperture faintly iridescent. Operculum circular, thin, horny, yellowish brown, of about eight spirals.

Diameter 12·0 mm.; height 11·75 mm. (holotype).

TYPE LOCALITY. St. WS 766. Between Falkland Is. and Argentina, 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.

St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229–236 m.
St. WS 237. North of Falkland Is., 46° 00′ S, 60° 05′ W, 7 July 1928, 150 m.
St. WS 244. West of Falkland Is., 52° 00′ S, 62° 40′ W, 18 July 1928, 253 m.*
St. WS 869. Between Falkland Is. and Patagonia, 52° 15′ 30″ S, 64° 13′ 45″ W, 31 Mar. 1932, 187–0 m.

DENTITION. Fig. G, 11, p. 189. 10+5+1+5+10. The cusps on the first and second laterals are exceptionally long. Lateral number 3 has a very broad base and numbers 4 and 5 are large, long and hooked, closely resembling in form the innermost enlarged marginals of the Calliostomids. In the figure only the upper portions of numbers 4 and 5 are drawn, and they are shown in relation to the central and laterals 1–3, but from the row immediately below. The two outer laterals are actually superimposed upon numbers 2 and 3. The marginals are long, slender and curved.

ANIMAL. Head narrow behind but broad in front, with a deeply laciniated fringe overhanging the small mouth. In front of the mouth there are folded laciniated lappets. Epipodial fringe with three slender tentacles, anterior one long, others reducing in size towards the head (Fig. D, 3).

Family LIOTIIDAE

Genus **Cirsonella** Angas, 1877

Type: *Cirsonella australis* Angas

Cirsonella extrema Thiele

Cirsonella extrema Thiele, 1912, p. 191, pl. 11, fig. 23.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 351 m. (one empty shell).

Genus **Brookula** Iredale, 1912

Type (o.d.): *Brookula stibarochila* Iredale, Kermadec Islands

The following four species are certainly congeneric and conform with the superficial features of *Brookula*. However, since the soft parts of these minute shells are unknown, the generic identity of these antarctic and subantarctic species of the American Quadrant is provisional only.

Brookula calypso (Melvill & Standen)

Cyclostrema calypso Melvill & Standen, 1912, p. 345, pl. 1, fig. 3.

TYPE LOCALITY. Burdwood Bank, south of Falkland Is., 54° 25′ S, 57° 32′ W, 56 fathoms.

St. 51. Off Eddystone Rock, east of Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 115 m.

* The single half-grown example from St. WS 244 is more definitely shouldered, but is otherwise typical.

Brookula pfefferi n.sp., Pl. V, fig. 8

Shell minute, solid, white, globose-turbinate, umbilicate, sculptured with crisp axial ribs and finer, closely spaced spiral threads. Whorls $4\frac{1}{2}$, including a smooth, globular protoconch of one whorl. Spire equal to height of aperture. Aperture circular with complete simple peristome. Axial sculpture of crisp narrow radials becoming weaker over the base, about twenty-four on the penultimate. Spiral threads about 12 on the penultimate and twenty-four on the body whorl, plus four very much stronger broad flat-topped cords within the funnel-shaped umbilical cavity, which rapidly contracts to a small deep pit. Operculum horny, circular and multispiral.

Height 2·0 mm.; diameter 1·75 mm.

TYPE LOCALITY. St 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m. (the holotype only).

This species is closely allied to *calypso* Melvill & Standen (1912) which is smaller, 1 · 1·15 mm., and lacks the four strong umbilical spirals.

Brookula strebeli n.sp., Pl. V, fig. 7

Shell minute, white, elongate-turbinate, imperforate, sculptured with crisp axial ribs and spiral threads. Whorls $3\frac{3}{4}$, including a smooth, globular protoconch of one whorl. Spire slightly taller than height of aperture. Aperture circular with complete simple peristome. Axial sculpture of prominent rounded radials becoming weaker over the base, about twenty-three on the penultimate. Spiral sculpture consisting of six moderately strong lirations on the upper spire-whorls and about sixteen on the body-whorl; they continue strongly for a short distance over the periphery and then suddenly diminish to minute, closely spaced threads, too indistinct to count, and finally there are four stronger spirals around the closed umbilical area.

Height 1·5 mm.; diameter 1·25 mm.

TYPE LOCALITY. St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m. (the holotype only).

This species is smaller than *pfefferi*, taller, imperforate and differently sculptured.

The names of Pfeffer and Strebel are associated with the two above new species in recognition of their respective major contributions on South Georgian molluscan systematics.

Brookula decussata (Pelseneer)

Cyclostrema decussatum Pelseneer, 1903, pl. 5, fig. 48.

TYPE LOCALITY. Bellingshausen Sea, 70° S, 80° 48′ W.

St. 182. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W, 14 Mar. 1927, 278–500 m.

The specimens from St. 182 seem to be identical with Pelseneer's species as far as I can judge from the rather sketchy illustration. They are very similar to *pfefferi*, but are smaller and have crisp, more definite sculpture with more numerous axials but fewer spirals.

Family TURBINIDAE

Genus **Homalopoma** Carpenter, 1864

Type (monotypy): *Turbo sanguineus* Linn. = *Leptothyra* Dall, 1871 (*non* Pease 1869)

Homalopoma cunninghami Smith

Collonia cunninghami Smith, 1881, p. 33, pl. 4, fig. 10.
Leptothyra cunninghami Pilsbry, 1888, p. 249.

TYPE LOCALITY. Port Rosario and Portland Bay, Patagonia.

St. 1321. From 4 miles S 72° W to 5·6 miles S 75° W of East Tussac Rock, Cockburn Channel, Tierra del Fuego, 16 Mar. 1934, 66 m.

One example of this attractive little rose-coloured, finely striated species; diameter 4·75 mm., height 4·0 mm. The operculum is calcareous and spirally grooved on its outer surface for $1\frac{1}{2}$ whorls, enclosing a roughened central area.

I have followed Vokes (1939, p. 179) in preferring *Homalopoma* to the better known name *Leptothyra*.

Genus **Leptocollonia** n.g.

Type: *Leptocollonia thielei* n.sp.

This new genus is provided for a southern group of *Homalopoma*-like (*Leptothyra*) shells which differ in being umbilicate, relatively thin-shelled, colourless, and in having a distinctive operculum, which is concave externally and deeply spirally channelled. The radula of *Leptocollonia* is very similar to that of *Homalopoma*, the chief difference being in the marginals, which are plain in the former and serrated in the latter.

Thiele's *Leptothyra innocens* (1912, p. 192, pl. 11, fig. 24) from Gauss Station, Antarctic, is a *Leptocollonia*, and the operculum of *Leptothyra* sp. (Thiele, loc. cit.), also from Gauss Station, is so similar to that of *thielei* n.sp. that it probably originated from this same species.

Leptocollonia thielei n.sp., Pl. V, fig. 9

Shell small, depressed-turbinate, perforate, dull yellowish buff, sculptured with narrow prominently raised spiral ridges. Whorls rounded, four, including the protoconch which is apparently one slightly convex and smooth whorl (protoconch eroded in all examples). First post-nuclear whorl with two spiral ridges, penultimate with from six to eight (seven plus an incipient eighth in holotype), body-whorl with fifteen, last two bordering the umbilicus, weak. The spirals are rounded but narrow and prominently raised with interspaces of from three to four times their width. The whole surface is crowded with delicate axial growth striae. Umbilicus narrow and deep, about one-ninth the major diameter, but half-obscured by the thin reflexed outer edge of the columellar callus. Peristome continued across the parietal wall by a thin glaze. Outer-basal lip thin and corrugated by the terminal points of the external spiral sculpture. The operculum is calcareous and multispiral of about seven whorls. Externally dull white, concave and deeply spirally channelled. Internally smooth and convex with a yellowish chitinous layer. The edge is thick, bevelled, with a median groove.

Diameter 9·0 mm.; height 7·5 mm. (holotype).

DENTITION. Fig. G, 13, p. 189. The radulae of these small Turbinids are most difficult to interpret on account of the minute size of the teeth and the complicated manner in which the bases overlap. My conclusions were made prior to reference to the results arrived at by Troschel & Thiele (1878, p. 213, pl. 22, fig. 7) and Tryon & Pilsbry (1888, pl. 60, fig. 73). The *Leptocollonia thielei* radula (Fig. G, 13) shows a marked resemblance to Pilsbry's figure of that of *Homalopoma carpenteri* (Fig. G, 14), and is almost totally at variance with Troschel and Thiele's interpretation based upon '*coccineus* Deshayes', the same species. The 'double-decked' appearance of the central tooth is not paralleled in any other known group. In both *Homalopoma* and *Leptocollonia* this tooth has a projecting plate above as well as below, and lateral wings form a broad arc across the median area. The central appears to be functionless, for it bears no cusps, just an irregular thickening at the crest of the median arc. The laterals, five in number, are long, excavated on the inner side to accommodate the lateral wings of the central, and produced on the outer side. These features are well developed in four of the laterals, but not in the fifth.

TYPE LOCALITY. St. 153. Off Cumberland Bay, South Georgia, 54° 08′ 30″ S, 36° 27′ 30″ W, 17 Jan. 1927, 106 m.

St. 20. 14·6 miles N 41 E of Cape Saunders, South Georgia, 4 Mar. 1926, 200 m.
St. 42. Off mouth of Cumberland Bay, South Georgia, 1 Apr. 1926, 120–204 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, 23 Dec. 1926, 122–136 m.
St. 156. North of South Georgia 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.
St. 190. Bismarck Strait, Palmer Archipelago, 24 Mar. 1927, 315 m.

Family LITTORINIDAE

Study of the radulae of the southern Laevilitorinids indicates a greater complexity than is suggested by their respective shells. Four genera have been in use—*Laevilitorina*, *Pellilitorina*, *Haloconcha* and *Macquariella*. The first, second and fourth names were proposed for antarctic-subantarctic shells, but the genotype of the third is northern and is based upon a little known and apparently quite local species from the Aleutian Islands.

Two main radula types are found in the southern shells: (*a*) with a broad, shallow-based central tooth bearing five cusps, and (*b*) with a narrow, deep-based central tooth, variously cusped. Type (*a*) is restricted to *Pellilitorina* and type (*b*) to the remainder. Type (*b*), however, subdivides into (*b* 1) with prominent, narrowly pointed cusps on both the central and lateral teeth, and (*b* 2) with very broad chisel-shaped cusps. Type (*a*) is found in relatively large, globose shells with only a narrow umbilical perforation and an epidermis covered with hair-like processes. Type (*b* 1) is found in *Laevilitorina*, which is small, ovate-conical and imperforate, and in *Macquariella*, which is small, subglobose and narrowly umbilicate. Type (*b* 2) is found in *Lacuna antarctica* Martens, 1885, which Thiele (1912) referred to *Haloconcha*; *Pellilitorina bransfieldensis* Preston, 1916, which is almost identical with *antarctica*; *Pellilitorina bennetti* Preston, 1916; and *Laevilitorina coriacea* Melvill & Standen, 1907.

The type (*b* 2) group, however, present three distinct shell types: (1) *antarctica* and *bransfieldensis*, which have a broad, depressed, heliciform shell with a wide umbilicus; (2) *bennetti*, which is globose and narrowly umbilicated; and (3) *coriacea*, which is ovate-conical and imperforate and of identical shape to *Laevilitorina*.

Several new names are required to arrange these shells in a natural grouping and they are diagnosed as follows:

Genus *Laevilitorina* Pfeffer, 1886 (Type: *Hydrobia caliginosa* Gould). Tierra del Fuego to Macquarie Island. Shell small, ovate conical, imperforate or almost so, epidermis smooth. Radula (Fig. I, 26) with a narrow central tooth, central and laterals with several prominent, narrowly pointed cusps, marginals fan-shaped and multidenticulate. Includes *pygmaea*, *venusta*, *granum* and *umbilicata* Pfeffer, 1886, South Georgia, *bennetti* and *latior* Preston, 1912, Falklands and probably *claviformis* Preston.

Subgenus *Corneolitorina* n.subg. (of *Laevilitorina*) (Type: *L. coriacea*, Melvill & Standen), South Orkneys. Shell small, ovate-conical, imperforate, as in *Laevilitorina*, but scarcely any shell substance apart from a thick leathery epidermis. Radula (Fig. I, 27) with a narrow central tooth, central and laterals with the main cusps blunt, chisel-shaped, marginals narrow with about seven denticles. Pelseneer's *L. elongata* (1903, pl. 5, fig. 58) from Two Hummocks Islands may belong here also.

Genus *Macquariella* Finlay, 1926 (Type *Paludestrina hamiltoni* Smith) Macquarie Island. Shell small, subglobose and narrowly umbilicated. Radula (Fig. I, 31) with an extremely narrow central tooth bearing only one long, sharp cusp, first lateral with a long central cusp and two shorter cusps, second lateral with three long cusps, marginals multidentate. Includes *Macquariella aucklandica* Powell, 1933, from Auckland, Chatham and Stewart Islands, New Zealand.

Genus *Laevilacunaria* n.g. (Type: *Pellilotorina bransfieldensis* Preston), South Shetlands. Shell

larger than that of *Laevilitorina*, depressed, heliciform with a wide umbilicus and smooth epidermis. Radula (Fig. I, 29) with a narrow central tooth, central and lateral teeth with broad chisel-shaped main cusps and weak side denticles, marginals foliate with few denticles. Includes *Lacuna antarctica* Martens from South Georgia and possibly *Hydrobia pumilis* Smith from Swains Bay, Kerguelen Island.

Since these southern Littorinids vary in shape between ovate-conical and depressed helicoid forms, even within one radula group, the use of the northern genus name *Haloconcha* for this group, merely upon external resemblances, is undesirable. Until some knowledge of the animal of *Haloconcha* is available it is more satisfactory to disassociate the southern shells under a new generic name.

Subgenus *Pellilacunella* n.subg. (of *Laevilacunaria*) (Type: *Pellilitorina bennetti* Preston), South Shetlands. Shell larger than that of *Laevilitorina*, globose, narrowly umbilicated and with a smooth epidermis. The radula (Fig. I, 30) resembles that of *Laevilacunaria*, except that the broad chisel-shaped cusps are denticulated along their cutting edges.

Genus *Pellilitorina* Pfeffer, 1886 (Type: *Littorina setosa* Smith), Kerguelen Island, South Georgia and South Orkneys. Shell relatively large, globose, narrowly umbilicated; epidermis set with hair-like processes. Radula (Fig. I, 32) with a broad shallow-based central tooth, bearing five cusps, the middle one strongest, laterals with three strong cusps, marginals foliated and with several denticles.

Genus Laevilitorina Pfeffer, 1886

Type (Suter, 1913): *Hydrobia caliginosa* Gould

Laevilitorina caliginosa (Gould)

Littorina caliginosa Gould, 1848, p. 83.
Hydrobia caliginosa Smith, 1879, p. 173, pl. 9, fig. 8.
Laevilitorina caliginosa Martens & Pfeffer, 1886, p. 81, pl. 1, fig. 8*a–d*.
Laevilitorina caliginosa Tryon, 1887, p. 254, pl. 46, fig. 29.
Laevilitorina caliginosa Pelseneer, 1903, p. 8.
Laevilitorina caliginosa Lamy, 1906*a*, p. 112.
Littorina (*Laevilitorina*) *caliginosa* Melvill & Standen, 1907, p. 100.
Laevilitorina caliginosa Strebel, 1908, p. 50.
Laevilitorina caliginosa Lamy, 1911*a*, p. 8.
Laevilitorina caliginosa Thiele, 1912, p. 235.
Littorina (*Laevilitorina*) *caliginosa* Melvill & Standen, 1912, p. 348.
Laevilitorina caliginosa Melvill & Standen, 1914, p. 118.
Laevilitorina caliginosa Hedley, 1916, p. 45.
Laevilitorina caliginosa var. L. David, 1934, fig. 1*a–d*.

DENTITION. Fig. I, 26.

TYPE LOCALITY. Royal Sound, Kerguelen I. (Suter, 1913)

St. 122. Maiviken, West Cumberland Bay, South Georgia, 14 Dec. 1926, 0–1 m.
St. MS 70. Maiviken, West Cumberland Bay, South Georgia, 9 Mar. 1926, shore coll.
St. WS 564. Moltke Harbour, South Georgia, 21 Feb. 1931, shore coll.

RANGE. Kerguelen I. (Gould, 1849; Smith, 1879; Thiele, 1912), Macquarie I. (Suter, 1913; Hedley, 1916), South Georgia (Pfeffer, 1886; Strebel, 1908; David, 1934), South Orkneys (Lamy, 1906*a*), South Shetlands (Lamy, 1911*a*), Falkland Is. (Melvill & Standen, 1907, 1912; Strebel, 1908), Tierra del Fuego (Tryon, 1887).

In all probability more than one species is covered in the above locality records. It may be noted that Strebel (1908) proposed *Laevilitorina caliginosa aestualis* for a shell from Port Louis, Falkland Islands, noting that it was only half as large as the South Georgia form. Also Macquarie Island shells

are very thin, never more than 4 mm. in height and show a narrow umbilical cleft, while those from South Georgia are more solid, from 6 to 8 mm. in height, and have a spreading parietal callus without a definite umbilical cleft. A range of topotypes will be required before anything further can be done.

Laevilitorina claviformis Preston

Laevilitorina claviformis Preston, 1916, p. 270, pl. 13, fig. 3.

TYPE LOCALITY. Deception Harbour, South Shetlands, on rocks at low water.

St. 179. Melchior I., Schollaert Channel, Palmer Archipelago, in creek to south of south-west anchorage, 10 Mar. 1927, 4–10 m.

Subgenus **Corneolitorina** n.subg.

Type: *Laevilitorina coriacea* Melvill & Standen

(See above for diagnosis)

Laevilitorina (Corneolitorina) coriacea Melvill & Standen

Littorina (Laevilitorina) coriacea Melvill & Standen, 1907, p. 130, pl. , fig. 2.

TYPE LOCALITY. Scotia Bay, South Orkneys, 5–10 fathoms.

St. 166. South-east point of Paul Harbour, Signy I., South Orkneys, 19 Feb. 1927, shore coll.

DENTITION. Fig. I, 27, p. 191 (St. 166).

Pelseneer's *Laevilitorina elongata* (1903, pl. 5, fig. 58) from Two Hummocks Islands appears to be closely allied.

Genus **Laevilacunaria** n.g.

Type: *Pellilitorina bransfieldensis* Preston

(See above for diagnosis)

Laevilacunaria bransfieldensis (Preston)

Pellilitorina bransfieldensis Preston, 1916, p. 271, pl. 13, fig. 5.

TYPE LOCALITY. From stomachs of fish taken in Bransfield Straits, off Deception I., South Shetlands.

St. 1486. Harmony Cove, Nelson I., South Shetlands, 3 Jan. 1935, shore coll.

Wilhelmina Bay, Danco Land, South Shetlands, 64° 30′ S, 62° W, 1–8 fathoms (A. G. Bennett).

Preston failed to recognize in the above species a very close relative of the South Georgian species described by Martens (1885, p. 92) as *Lacuna antarctica*. This species was admirably figured by Martens & Pfeffer (1886, pl. 2, fig. 1*a–f* and pl. 3, fig. 13), and on external characters there seems to be no obvious differences between figures of the South Georgian shell and actual paratypes of Preston's species. The radula of Preston's species, however, shows sufficient differences from that figured by Martens and Pfeffer for the South Georgian *antarctica*, to warrant recognition of both names for the present.

DENTITION. Fig. I, 29, p. 191. The radula in these shells is remarkable in having very broad chisel-shaped cusps on both the central and lateral teeth. In detail the central tooth of *bransfieldensis* differs from that of *antarctica* in being widest at the top, not medially, and in the cusp occupying most of the width of that tooth, not half the width as shown in Martens and Pfeffer's figure. In *bransfieldensis* both laterals have broad cusps with a small denticle on each side. In *antarctica*, however, the second lateral is shown with a reduced, chisel-shaped main cusp and two strong, pointed cusps on the inner side. These differences would seem greater than one can ascribe to either normal range of variation or to vagaries in interpretation.

A radula very similar to that of *bransfieldensis* is figured by Thiele (1929, p. 123) for *Carinolacuna carinifera* A. Adams from Borneo.

Subgenus **Pellilacunella** n.subg.

Type: *Pellilitorina bennetti* Preston

(See above for diagnosis)

Laevilacunaria (Pellilacunella) bennetti (Preston)

Pellilitorina bennetti Preston, 1916, p. 270, pl. 13, fig. 4.

TYPE LOCALITY. Bransfield Strait, South Shetlands, on seaweed, 15 fathoms.

St. 179. Melchior I., Schollaert Channel, Palmer Archipelago, in creek to south of south-west anchorage, 10 Mar. 1927, 4–10 m.

Height 2·0 mm.; diameter 2·0 mm. (holotype).

Height 5·4 mm.; diameter 5·0 mm. (St. 179).

Height 6·0 mm.; diameter 5·0 mm. (St. 179).

DENTITION. Fig. I, 30, p. 191 (St. 179).

The 'Discovery' shells attain a much larger size than Preston's holotype, but are assumed to be the adult of the species. The diagrams show an adult (Fig. M, 101) and a juvenile (Fig. M, 100) compared with a tracing of Preston's holotype (Fig. M, 99, p. 195).

Genus **Pellilitorina** Pfeffer, 1886

Type (Thiele, 1929): *Littorina setosa* Smith

Pellitorina setosa (Smith)

Littorina setosa Smith, 1875, p. 69.

Littorina setosa Smith, 1879, p. 172, pl. 9, fig. 6.

Pellilitorina setosa Martens & Pfeffer, 1886, p. 77, pl. 1, fig. 7*a*, *b*.

Littorina (*Pellilitorina*) *setosa* Smith 1902*b*, p. 204.

Littorina (*Pellilitorina*) *setosa* Melvill & Standen, 1907, p. 101.

Pellitorina (sic) *setosa* Strebel, 1908, p. 50.

Pellilitorina setosa Thiele, 1912, p. 235.

Pellilitorina setosa L. David, 1934, p. 127.

DENTITION. Fig. I, 32, p. 191.

TYPE LOCALITY. Swain's Bay, 3–4 fathoms, Kerguelen Island.

St. 145. Stromness Harbour, South Georgia, between Grass I. and Tonsberg Point, 7 Jan. 1927, 26–35 m.

St. 456. 1 mile east of Bouvet I., 18 Oct. 1930, 40–45 m.

St. 1941. Leith Harbour, South Georgia, 29 Dec. 1931, 55–22 m. (one empty shell).

St. MS 10. East Cumberland Bay, $\frac{1}{4}$ mile south-east of Hope Point, to $\frac{1}{4}$ mile south of Government Flagstaff, South Georgia, 14 Feb. 1925, 26–18 m.

St. MS 71. East Cumberland Bay, $9\frac{1}{4}$ cables E × S to 1·2 miles E × S of Sappho Point, South Georgia, 9 Mar. 1926, 110–60 m.

St. WS 25 Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.

RANGE. Kerguelen I.; Bouvet I. and Cape Adare (Smith, 1902); South Georgia (Pfeffer, Strebel and L. David) and South Orkneys (Melvill & Standen).

Pellilitorina pellita (Martens)

Littorina pellita Martens, 1885, p. 92.

Pellilitorina pellita Martens & Pfeffer, 1886, p. 79, pl. 1, fig. 6*a–c*.

Littorina (*Pellilitorina*) *pellita* Smith, 1902*b*, p. 204.

Littorina (*Pellilitorina*) *pellita* Melvill & Standen, 1907, p. 101.

Pellitorina (sic) *pellita* Strebel, 1908, p. 50.

Littorina (*Pelliltorina*) *pellita* Melvill & Standen, 1912, p. 348.

Pellilitorina pellita L. David, 1934, p. 127.

DENTITION. Fig. I, 33, p. 191.

TYPE LOCALITY. South Georgia.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m. (eroded dead shells).
St. 164. North of Normanna Strait, South Orkneys, near Cape Hansen, Coronation I., 18 Feb. 1927, 24–36 m.
Uruguay Bay, Laurie I., 3 Jan. 1933, 16 m., from weed on anchor.

Family RISSOIDAE

Genus **Ovirissoa** Hedley, 1916

Type (o.d.): *Rissoa adarensis* Smith

Ovirissoa georgiana (Pfeffer)

Rissoa georgiana Pfeffer, 1886, p. 92, pl. 2, fig. 3.
Rissoa georgiana Strebel, 1908, p. 54.
Ovirissoa georgiana Hedley, 1916, p. 47.

TYPE LOCALITY. South Georgia.

St. 28. West Cumberland Bay, South Georgia, 3·3 miles S 45° W of Jason Lt., 16 Mar. 1926, 168 m.
St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.

Genus **Subonoba** Iredale, 1915

Type (o.d.): *Rissoa fumata* Suter.

Subonoba cf. **paucilirata** (Melvill & Standen)

Rissoa (*Onoba*) *paucilirata* Melvill & Standen, 1912, p. 350, pl. 1, fig. 10.

TYPE LOCALITY. Burdwood Bank, 56 fathoms.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.

Subonoba fraudulenta (Smith, 1907)

Rissoa fraudulenta Smith, 1907, p. 9, pl. 2, fig. 3.
Rissoa fraudulenta Melvill & Standen, 1907, p. 103.
Rissoa fraudulenta Hedley, 1911, p. 5.
Rissoa fraudulenta Thiele, 1912, p. 194.

TYPE LOCALITY. McMurdo Sound.

St. 164. East end of Normanna Strait, South Orkneys, near Cape Hansen, Coronation I., 18 Feb. 1927, 24–36 m.

RANGE. Scotia Bay, South Orkneys, 6 fathoms (Melvill & Standen); Gauss Station (Thiele); McMurdo Sound, 10–20 fathoms (Hedley); Macquarie I. 69 m. (Tomlin, 1948).

Genus **Eatoniella** Dall, 1876

Eatonia Smith, 1875 *non* Hall, 1857

Type (o.d.): *Eatonia kerguelenensis* Smith

Eatoniella kerguelenensis major Strebel

Eatoniella kerguelenensis forma *major* Strebel, 1908, p. 57, pl. 4, fig. 56*a–c*.
Eatoniella kerguelenensis major Melvill & Standen, 1912, p. 351.

TYPE LOCALITY. Cumberland Bay, South Georgia, low tide.

St. 163. Paul Harbour, Signy I., South Orkneys, 17 Feb. 1927, 18–27 m.

RANGE. Recorded also from Scotia Bay, South Orkneys, 9–10 fathoms (Melvill & Standen, 1912); south-west of Snow Hill I., 64° 36′ S, 57° 42′ W, 125 m.; South Georgia, 22 m.; Astrolabe I., 63° 9′ S, 58° 17′ W, 95 m. (Strebel, 1908).

Family TROCHACLIDIDAE

Genus Trochaclis Thiele, 1912

Type (monotypy): *Trochaclis antarctica* Thiele

Trochaclis antarctica Thiele

Trochaclis antarctica Thiele, 1912, p. 192, pl. 11, fig. 29.
Trochaclis antarctica Hedley, 1916, p. 51.

TYPE LOCALITY. Gauss Station.

St. 1652. Ross Sea, 75° 56′ 2″ S, 178° 35′ 5″ W, 23 Jan. 1936, 567 m.
St. 1658. Off Franklin I., Ross Sea, 76° 09′ 6″ S, 168° 40′ E, 26 Jan. 1936, 520 m.

Hedley (1916) recorded the species from off the Shackleton Ice-shelf, 65° 20′ S, 95° 27′ E in 240 fathoms.

Family CERITHIIDAE

Genus Ataxocerithium Tate, 1893

Type (o.d.): *Cerithium serotinum* Adams, Tasmania

The Magellan species *pullum* is referred to the above genus with some hesitation, since I know nothing of either the opercular or the radula characters of the Tasmanian genotype. On shell features, however, *pullum* is not dissimilar from *serotinum*.

The operculum in *pullum* is ovate, slightly D-shaped, paucispiral, with the nucleus near to the inner lower margin, which makes it a typical member of the Cerithiidae. The protoconch is very small and slender, consisting of $1\frac{1}{2}$ smooth papillate whorls followed by $1\frac{1}{2}$ whorls of brephic axials. The radula is of the same general type as that of *Cerithium* except for the marginals, which have, in addition to their normal bifid extremities, several well-developed cusps, which branch at right angles from the ventral margin. There is only one of these side cusps on the inner marginal, but there are three on the outer marginal. There is nothing comparable with these marginals in the Cerithiidae radulae figured by Troschel (1858, pls. 9–12).

Ataxocerithium pullum (Philippi)

Cerithium pullum Philippi, 1845*b*, p. 66.
Cerithium caelatum Couthouy, 1849, p. 148, fig. 174*a–d*.
Cerithium pullum Rochebrune & Mabille, 1889, p. H 40.
Cerithium pullum Strebel, 1905*b*, p. 652, pl. 23, fig. 40*a–d*.
Cerithium pullum Melvill & Standen, 1907, p. 105.
Cerithium pullum Strebel, 1908, p. 47.
Cerithium pullum Melvill & Standen, 1912, p. 351.

DENTITION. Fig. I, 34, p. 191. St. WS 225. PROTOCONCH. Fig. N, 102, p. 196.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., 7 miles N 50° E to 7·6 miles N 63° E, 4 May 1926, 105–115 m.
St. 388. Off Tierra del Fuego, 56° $19\frac{1}{2}$′ S, 67° $09\frac{3}{4}$′ W, 16 Apr. 1930, 121 m.
St. WS 72. Off north coast of East Falkland Is., 51° 07′ S, 57° 34′ W, 5 Mar. 1927, 79 m.
St. WS 86. Burdwood Bank, 53° 53′ S, 60° 37′ W, to 53° 54′ S, 60° 32′ W, 3 Apr. 1927, 151–147 m.
St. WS 97. North-west of Falkland Is., 49° S, 62° W to 49° 01′ S, 61° 56′ W, 18 Apr. 1927, 146–145 m.
St. WS 225. North-west of Falkland Is., 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m.
St. WS 239. North-west of Falkland Is., 51° 10′ S, 62° 10′ W, 15 July 1928, 196–192 m.
St. WS 243. Between Falkland Is. and Point Santa Cruz, Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m
St. WS. 247. North of Falkland Is., 52° 40′ S, 60° 05′ W, 19 July 1928, 172 m.
St. WS 250. North of Falkland Is., 51° 45′ S, 57° W, 20 July 1928, 251-313 m.

St. WS 750. North-east of Falkland Is., 50° 50′ S, 57° 15′ 13″ W, 18–19 Jan. 1932, 95 m.

St. WS 824. Off East Falkland Is., 52° 29′ S, 58° 27′ W, 19 Jan. 1932, 146–137 m.

St. WS 865. Between Falkland Is. and Patagonia 50° 03 S, 64° 14 W, 29 Mar. 32, 128–126 m.

RANGE. Patagonia, Burdwood Bank (Melvill & Standen, 1912) and Falkland Is., 8–196 m.

Genus **Cerithiella** Verril, 1882

n.nom. for *Lovenella* Sars, 1878, *non* Hincks, 1869

Type (monotypy): *Cerithium metula* Loven

Strebel (1908) and Thiele (1912) have placed a number of small Antarctic species in this Recent European genus. These shells conform to the genotype in having a stout, bulging, smooth protoconch of about two whorls and similar apertural features, but two series are represented: (1) *astrolabiensis* Strebel, 1908, *erecta* Thiele, 1912, *similis* Thiele, 1912, and *seymouriana* Strebel, 1908, all of which have plain spiral keels without axials; and (2) *superba* Thiele, 1912, and *werthi* Thiele, 1912, which, like the genotype, have the spiral keels crossed and beaded by axials.

The two empty shells recorded below provide no additional information concerning the relationships of these southern groups, so Thiele's placing is retained.

Cerithiella seymouriana (Strebel)

Bittium seymourianum Strebel, 1908, p. 47, pl. 4, fig. 50*a–c*.
Cerithiella seymouriana Thiele, 1912, p. 261.

TYPE LOCALITY. South-east of Seymour I., 64° 20′ S, 56° 38′ W, 150 m.

St. WS 33. Off South Georgia, 54° 59′ S, 35° 24′ W, 21 Dec. 1926, 130 m.

One example, 8 × 2·4 mm., compared with 8·2 × 2·9 mm. for Strebel's type.

Cerithiella astrolabiensis (Strebel)

Bittium astrolabiensis Strebel, 1908, p. 48, pl. 4, fig. 51*a–c*.
Cerithiella astrolabiensis Thiele, 1912, p. 261.

TYPE LOCALITY. Astrolabe I., 63° 9′ S, 58° 17′ W, 95 m.

St. 363. 2·5 miles S 80° E of South-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–298 m.

Strebel's type was a juvenile of five post-nuclear whorls and measured 3·3 × 1·3 mm. The St. 363 example, which I judge to be the adult of this species, has 9½ post-nuclear whorls and measures 11·5 × 3·9 mm. The species differs from *seymouriana* only in being proportionately broader and more tightly coiled.

Family TURRITELLIDAE

Genus **Turritellopsis** Sars, 1878

Type (monotypy): *Turritellopsis acicula* Stimpson
Recent, North Atlantic

Turritellopsis thielei n.sp., Pl. VII, fig. 26

Shell with an attenuated spire of slowly increasing whorls, sculptured with prominent flat-topped spiral cords, four to five per whorl. The spiral cords are separated by interspaces of about 1½ times their width, except for the uppermost, which has a double space between it and the suture, and the lowest, which is almost joining the suture below. The body-whorl has the addition of six cords on the base, but the lower two or three are weak. In the paratype, which is a young shell, the subsutural space is occupied by two subsidiary linear-spaced cords, which are much weaker than the rest. Aperture subcircular, the columellar-basal portion of the peristome split in two by a deep median groove. Both examples have the early whorls missing.

Length (4 whorls only) 8·5 mm.; diameter 3·8 mm. (holotype).

Length ($5\frac{3}{4}$ whorls only) 9·25 mm.; diameter 3·0 mm. (paratype).

TYPE LOCALITY. St. 181. Schollaert Channel, Palmer Archipelago, 64° 20′ S, 63° 01′ W, 12 Mar. 1927, 160–335 m.

The species is nearest related to *Turritellopsis gratissima* Thiele from Gauss Station, Davis Sea, which has one spiral less per whorl.

It is possible that my paratype of *theilei* is not identical with the holotype, but more material is necessary to determine this.

These Antarctic species seem to be correctly placed in *Turritellopsis*, the radula of which lacks marginal teeth. Thiele (1912, pl. 15, fig. 23) figured the dentition of his *T. gratissima*, and this also shows three teeth only, a central and a pair of laterals only.

Genus Colpospirella n.g.

Type: *Turritella algida* Melvill & Standen

This is a very small Turritellid, apparently never more than 6 mm. in height, having a relatively large, smooth, papillate protoconch of $2\frac{1}{2}$ whorls, the last with a blunt median keel. The protoconch is very like that of the Australian *Colpospira*, but the labial profile is only moderately sigmoid, not deeply sinused as in the Australian genus.

Colpospirella algida (Melvill & Standen)

Turritella algida Melvill & Standen, 1912, p. 352, pl. fig. 14.

TYPE LOCALITY. Burdwood Bank, south of the Falkland Is., 56 fathoms.

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason Lt., 15 Mar. 1926, 110 m.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 15 Jan. 1927, 155–178 m.

St. WS 816. West of Falkland Is., 52° 09′ 45″ S, 64° 56′ W, 14 Jan. 1932, 150 m.

St. WS 210. North of Falkland Is., 50° 17′ S, 60° 06′ W, 29 May 1928, 161 m.

St. WS 211. 50° 17′ S, 60° 06′ W, 29 May 1928, 174 m.

St. WS 838. Between Falkland Is. and Patagonia, 53° 11′ 45″ S, 65° W, 5 Feb. 1932, 148 m.

Genus Mathilda Semper, 1865

Type: *Turbo quadricarinata* Brocchi, Pliocene, Italy

Mathilda malvinarum (Strebel)

Cerithiopsis malvinarum Strebel, 1908, p. 49, pl. 1, fig. 10*a–c*.

TYPE LOCALITY. Port Louis, Falkland Is., 1 m.

St. WS 225. North-west of Falkland Is., 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m.

St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.

Family EULIMIDAE

Genus Balcis Leach, 1847

Type: *Balcis montagui* (= *B. alba* da Costa)

Balcis antarctica (Strebel)

Eulima antarctica Strebel, 1908, p. 65, pl. 6, fig. 91*a–c*.

TYPE LOCALITY. South-east of Seymour I., 64° 20′ S, 56° 38′ W, 150 m.

St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m.

Melvill & Standen (1912, p. 352) ascribed to this species an immature example from Burdwood Bank in 56 fathoms, but the record requires confirmation.

Balcis cf. tumidula (Thiele)

Eulima tumidula Thiele, 1912, p. 193, pl. 11, fig. 31.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.

If I have correctly determined the St. 170 shells, the species attains a larger size than cited by Thiele.
Height 5·25 mm.; diameter 2·0 mm. (holotype).
Height 8·0 mm.; diameter 3·2 mm. (St. 170).

Balcis cf. solitaria (Smith)

Eulima solitaria Smith, 1915, p. 64, pl. 1, fig. 3.

TYPE LOCALITY. Off Cape Bird Peninsula, 250 fathoms, McMurdo Sound.

St. 190. Bismarck Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Mar. 1927, 93–130 m.

One example, 8·34 × 2·8 mm., of $8\frac{1}{2}$ whorls, which appears to be the adult of Smith's species of seven whorls and dimensions of 4 × 1·5 mm.

Family EPITONIIDAE

Genus Cirsotrema Moerch, 1852

Type: *Scalaria varicosa* Lamarck

Cirsotrema magellanica (Philippi)

Scalaria magellanica Philippi, 1845*b*, p. 46.
Scalaria (*Opalia*) *magellanica* Strebel, 1905*b*, p. 656, pl. 23, fig. 44*a–f*.
Scalaria magellanica Strebel, 1908, p. 63.
Scala magellanica Melvill & Standen, 1912, p. 347.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.
St. WS 228. Off north-east end of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229 m.

RANGE. Lively I., Falkland Is. (Strebel, 1905); Port William, 40 m., Falkland Is. (Strebel, 1908); Punta Arenas (shore), Puerto Harris, 15 fathoms (Strebel, 1905); Burdwood Bank, 56 fathoms (Melvill & Standen, 1912).

Cirsotrema magellanica latecostata (Strebel)

Scalaria magellanica var. *latecostata* Strebel, 1905*b*, p. 658, pl. 23, figs. 43*a–d*.

TYPE LOCALITY. Strait of Magellan.

St. 388. Between Cape Horn and Staten I., 56° $19\frac{1}{2}$′ S, 67° $09\frac{3}{4}$′ W, 16 Apr. 1930, 121 m.
St. WS 222. Between Patagonia and Falkland Is., 48° 23′ S, 65° W, 8 June 1928, 100–106 m.
St. WS 766. Between Falkland Is. and Argentina, 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.
St. WS 797. Between Patagonia and Falkland Is., 47° 45′ 18″ S, 64° 10′ 30″ W, to 47° 47′ 43″ S, 64° 07′ 30″ W, 19 Dec. 1931, 117 m.

Cirsotrema fenestrata (Strebel)

Scalaria fenestrata Strebel, 1908, p. 63, pl. 4, fig. 61*a–d*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 253–310 m.

St. 140. Stromness Harbour to Larsen Point, South Georgia. From 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m. (one half-grown example).

Genus Aeirsa Moerch, 1857

Type (Cossmann, 1912): *Scalaria costulata* Mighels

Acirsa antarctica (Smith)

Scala antarctica Smith, 1907, p. 8, pl. 1, figs. 10, 10*b*.
Epitonium antarcticum Smith, 1915, p. 64.

TYPE LOCALITY. Hole 12, 'Discovery' Winter Quarters, McMurdo Sound.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m. (two juveniles).

Recorded by Smith (1915) from the Ross Sea, 158 fathoms.

Acirsa anneetens n.sp. Pl. VII, fig. 23

Shell moderately large, attenuated, of rapidly increasing convex whorls, dull white, solid, axially costate but axials subobsolete on last two whorls. A prominent supra-sutural spiral fold forms a heavy carina on the last whorl. Protoconch missing, 6½ post-nuclear whorls remaining in holotype, the only adult specimen. The axials number about twenty on the early whorls. The whole surface is crossed by subobsolete spiral cords too indistinct to be accurately counted but approximately twenty on the penultimate.

Height 11·5 mm.; diameter 4·5 mm.

TYPE LOCALITY. St. WS 766. North of Falkland Is. 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.

The species resembles *antarctica* Smith, but is not so definitely sculptured and has a more massive sutural carina.

Family NATICIDAE

Genus Amauropsis *Moerch*, 1857

Type (s.d. Dall, 1909): *Natica helicoides* Johnson

Hedley (1916) diagnosed an Antarctic series of Naticoids as follows: 'There is an Antarctic naticoid group which cannot be received by any of the above (i.e. *Natica*, *Cochlis*, *Cryptonatica*, *Polinices*, *Euspira*, *Cepatia*, *Mamillaria*), or by other known extra-limital groups such as *Cernina* or *Mammilla*, not discussed by Dr Dall. So far this amounts to about a dozen rather featureless species, all small, mostly uniform olive buff in colour, four whorls, a slightly raised spire, a caducous epidermis, comparatively thin, unsculptured, except for incremental striae, without umbilical funicle or a callus pad at the insertion of the right lip. Operculum corneous paucispiral.'

Unfortunately, in nominating the Recent south-eastern Australian *Natica beddomei* Johnston as genotype of his new genus *Friginatica*, Hedley has in effect deviated from his intention, for *beddomei* as figured by Watson (1886, pl. 28, fig. 3) is a small solid shell with a channelled suture but apparently no epidermis.

Smith (1907) used the Arctic Recent genus *Amauropsis* for one of this Antarctic series, i.e. *A. rossiana* Smith from 'Discovery' Winter Quarters, and since these shells fit this genus in a general way there is no reason why at this stage of our knowledge *Amauropsis* should not be used. The genotype of *Amauropsis* is a large shell (1–1·5 in.), thin, with channelled suture; umbilicus a narrow line; chalky white, covered with a light yellowish brown epidermis (Tryon, 1886, p. 53, pl. 22, fig. 31). The operculum is horny.

There is no marked difference between the radula of the Arctic *helicoides* (Troschel, 1861, pl. 15, fig. 6) (Fig. J, 41) and that of the Antarctic *anderssoni* Strebel, *aureolutea* Strebel and *rossiana* (Eales, 1923) (Fig. J, 43). Each has a tricuspid central tooth, a bifid inner marginal and a simple outer marginal.

The laterals alone vary slightly in that those of *helicoides*, *anderssoni* and *rossiana* are tricuspid and those of *aureolutea* bicuspid. The Antarctic members range in height between 6 (*georgianus*) and 30 mm. (*aureolutea*).

Amauropsis anderssoni (Strebel) Pl. X, figs. 58, 59

Natica anderssoni Strebel, 1906, p. 142, pl. 11, fig. 67*a*, *b*.
Natica anderssoni Strebel, 1908, p. 61, pl. 5, fig. 64*a*, *b*.

TYPE LOCALITY. Falkland Is.

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason Lt, 15 Mar. 1926, 110 m.
St. 30. West Cumberland Bay, South Georgia, 2·8 miles S 24° W of Jason Lt., 16 Mar. 1926, 251 m.
St. 39. East Cumberland Bay, South Georgia, from 8 cables S 81° W of Merton Rock to 1·3 miles N 70 E of Macmahon Rock, 25 Mar. 1926, 179–235 m.
St. 42. Off mouth of Cumberland Bay, South Georgia, 1 Apr. 1926, 120–204 m.
St. 123. Off mouth of Cumberland Bay, South Georgia, 15 Dec. 1926, 230–250 m.
St. 1941. Leith Harbour, South Georgia, 29 Dec. 1936, 55–22 m.
St. MS 68. East Cumberland Bay, 1·7 miles S ½° E to 8½ cables SE × E of Sappho Point, 2 Mar. 1925, 220–247 m.
St. WS 32. Mouth of Drygalski Fjord, South Georgia, 21 Dec. 1926, 91–225 m.
St. WS. 62. Wilson Harbour, South Georgia, 19 Jan. 1927, 15–45 and 26–83 m.

RANGE. Falkland Is. and South Georgia, 20–310 m.

The 'Discovery' material is identical with examples examined from the Swedish South Polar Expedition's St. 34, off Cumberland Bay, South Georgia, 252–310 m., but I have not seen Falkland examples.

DENTITION. Fig. J, 44, p. 192.

Amauropsis aureolutea (Strebel)

Natica aureolutea Strebel, 1908, p. 63, pl. 5, fig. 63*a*, *b*.

TYPE LOCALITY. South Georgia, 24–52?m.

St. 140. Stromness Harbour to Larsen Point, South Georgia, 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.
St. 159. North-east of South Georgia, 53° 52′ 30″ S, 36° 08′ 00″ W, 21 Jan. 1927, 160 m.
St. 170. Off Cape Bowles, Clarence Is., 61° 25′ 30″ S, 53° 46′ 00″ W, 23 Feb. 1927, 342 m.
St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m
St. WS 177. Off south-east of South Georgia, 54° 58′ S, 35° 00′ W, 7 Mar. 1928, 97 m.

RANGE. South-west of Snow Hill I., 64° 36′ S, 57° 42′ W, 152 m. (Strebel); Clarence Is., South Sandwich Is. and South Georgia, 24–342 m.

The 'Discovery' material is identical with examples examined from the Swedish South Polar Expedition's St. 6, south-west of Snow Hill Island, 125 m. The species differs from *anderssoni* in having a brighter epidermis which is orange brown, subobsolete spiral ridges, and in being larger with a taller spire. The apical whorls are almost invariably eroded.

The largest 'Discovery' example is 27 mm. in height and 24 mm. in diameter (St. WS 177). Strebel's type is 14·9 × 14·2 mm.

DENTITION. Fig. J, 42, p. 192.

Amauropsis rossiana Smith

Amauropsis rossiana Smith, 1907*a*, p. 5, pl. 1, figs. 6, 6*a*.
Amauropsis rossiana Smith, 1915, p. 69.
Pellilitorina rossiana Hedley, 1916, p. 52.
Amauropsis rossiana Eales, 1923, pp. 19, 21, fig. 21.

Type locality. Hut Point, 'Discovery' Winter Quarters, McMurdo Sound.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m. (one juvenile, 12 × 11·5 mm.).

Range. McMurdo Sound, 140–300 fathoms; off Mertz Glacier Tongue, Adelie Land, 288 fathoms; Ross Sea.

Dentition. Fig. J, 43, p. 192 (Eales, 1923, loc. cit. p. 21, fig. 21).

This species is very closely allied to *aureolutea*, but has a more deeply impressed suture and the spiral sculpture is more pronounced. The operculum is horny.

The solitary 'Discovery' example has a slightly lower spire than topotypic examples from McMurdo Sound, 250 fathoms.

Amauropsis georgianus Strebel

Natica georgiana Strebel, 1908, p. 62, pl. 5, fig. 65*a*, *b*.

Type locality. South Georgia, 64–74 m.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 238–270 m.

I have not seen type material, but suspect that this may be merely a form of *anderssoni*.

Subgenus **Kerguelenatica** n.subg.

Type: *Natica grisea* Martens, 1878

At least subgeneric status is warranted for *grisea*, for it has an operculum which is formed of both horny and calcareous materials. It is admirably described by Watson (1886, p. 432) as follows: 'It has a thinnish calcareous layer over a pretty strong horny interior, which projects uncovered round the entire edge, but this uncovered edge is narrowest on the inner side, i.e. near the pillar of the shell or spire of the operculum. Here the exterior flat surface of the calcareous layer is thickened by a thin, dirty grey, spreadout spot of limy substance. Beyond this spot the surface of the calcareous layer is strongly scored with radiating lines. Its inner surface can be seen through the horny layer to be sharply and delicately striate spirally.' Like the *Amauropsis* series the shell lacks a funicular callus and has a thick yellowish brown epidermis.

As already explained under *Amauropsis*, the species *grisea* cannot be covered by *Friginatica* as Hedley intended, for the south-eastern Australian genotype, *beddomei*, apparently lacks epidermis, and according to Cotton (1931, p. 20) the operculum is horny.

Unfortunately, in describing the Macquarie Island *Friginatica pisum* Hedley (1916) made no reference to the operculum, but Tomlin (1948), p. 228, remarked that it is 'dark coloured and horny.' The species may be located provisionally in *Amauropsis*. I favour reinstating Marwick's *Sulconacca* (1924, p. 556), type: *S. vaughani* Marwick, Lower Miocene, New Zealand, in preference to *Friginatica* which becomes restricted to its Recent south-eastern Australian genotype. *Sulconacca* has the umbilical area margined by a strong spiral ridge.

The presumed occurrence of *Amauropsis* in both the Arctic and Antarctic regions may seem unnatural and certainly brings up once more the question of bipolarity.

Amauropsis is a high-latitude stenothermic mollusc related to *Polinices*, which is widely distributed in warmer seas. *Polinices* is of considerable antiquity (common in the Tertiary of most regions), and it is likely that *Amauropsis* also had sufficient time and opportunity during the colder periods of the Pleistocene to accomplish bipolar distribution. The new subgenus *Kerguelenatica* is considered to be a local product from *Amauropsis* originating in the Kerguelenian Province. From consideration of time *Sulconacca* is probably not related nor is *Friginatica* in its restricted usage.

Amauropsis (Kerguelenatica) grisea (Martens), Pl. X, fig. 60

Natica grisea Martens, 1878, p. 24.
Natica grisea Watson, 1886, p. 432, pl. 28, fig. 5.
Natica delicatula Smith, 1902, p. 206, pl. 24, fig. 6.
Natica grisea Martens & Thiele, 1903, p. 64, pl. 4, figs. 2, 3, and pl. 8, fig. 44 (radula).
Natica grisea Strebel, 1908, p. 61.
Natica delicatula Thiele, 1912, p. 199, pl. 12, figs. 16, 17.
Natica grisea Smith, 1915, p. 69.
Friginatica grisea Hedley, 1916, p. 52.
Polinices (*Lunatia*) *grisea* L. David, 1934, p. 128.

TYPE LOCALITY. Kerguelen I.

St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 456. 1 mile east of Bouvet I., 18 Oct. 1930, 40–45 m. (two empty shells).
St. 1660. Ross Sea, 74° 46′ 45″ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.
St. 1952. Between Penguin I. and Lion's Rump, King George Is., South Shetlands, 11 Jan. 1937, 367–383 m.

RANGE. Graham Land, 64° 3′ S, 56° 37′ W, 360 m. (Strebel); South Shetlands; South Georgia, 252–310 m., and between South Georgia and Falkland Islands, 2675 m. (Strebel); Bouvet I.; Kerguelen I., 25–95 fathoms (Watson); Cape Adare, 26 fathoms (Smith); McMurdo Sound, 190–250 fathoms (Smith); Commonwealth Bay, 25 fathoms and off Shackleton Ice-shelf, 240 fathoms (Hedley); Ross Sea.

The species is easily recognized, as explained above, by the composite nature of the operculum, which is horny but with an outer limy covering. It is possible that more than one species is represented in the range covered, but I do not have access to sufficient material to determine this. The South Georgian? shell figured by Strebel (1908) is not so depressed as Kerguelen topotypes, two of which, from Royal Sound, 20 fathoms (British Museum) are figured.

DENTITION. Fig. J, 45, p. 192 (Martens & Thiele, 1903).

Genus **Polinices** Montfort, 1810

Type (o.d.): *Polinices albus* Montfort = *Nerita mammilla* Linn., West Indies

Polinices patagonicus (Philippi)

Natica patagonica Philippi, 1845*b*, p. 65.
Natica patagonica Hupé (Gay), 1854, p. 221.
Natica patagonica Tryon, 1886, p. 37, pl. 14, fig. 24.
Natica patagonica Rochebrune & Mabille, 1889, p. H 35.
Natica patagonica Strebel, 1906, p. 137, pl. 11, fig. 63.
Natica patagonica Strebel, 1908, p. 61.

TYPE LOCALITY. North-east Strait of Magellan.

St. 158. North-east of South Georgia, 53° 48′ 30″ S, 35° 57′ 00″ W, 21 Jan. 1927, 401–411 m.
St. WS 247. South of Falkland Is., 52° 40′ S, 60° 05′ W, 19 July 1928, 172 m.

RANGE. Strait of Magellan (type); Punta Arenas, Tierra del Fuego and Puerto Pantalon, 7 fathoms (Strebel); Lively I., Falkland Is. (Strebel); South Georgia.

The 'Discovery' material consists of two badly eroded shells which are probably the above species. They measure respectively: height 28·5 mm., diameter 27 mm. (St. WS 247); height 26 mm., diameter 22 mm. (St. 158).

Genus Falsilunatia n.g.

Type: *Natica soluta* Gould, 1848

On shell and opercular characters *soluta* is not dissimilar from *catena* Da Costa, the Recent English genotype of *Lunatia*, but the dentition is most distinctive.

In *catena* the radula is normal for the family—a tricuspid central tooth of more or less rectangular form, laterals with three or four cusps and the inner marginal with a side cusp, thus approximating the bifid form. In *soluta* the central tooth is hemispherical with a large, broadly triangular central cusp but merely vestigial side cusps. The laterals have a broad massive cusp with a slight incision or incipient denticle near the base of its inner margin. The marginals are simple, not bifid, the outer one the longer.

The umbilicus is narrower than in *Lunatia* and may be open or closed according to the relative downward encroachment of the parietal callus.

Falsilunatia soluta (Gould)

Natica soluta Gould, 1848, p. 239.
Natica soluta Tryon, 1886, p. 39, pl. 9, fig. 71.
Natica soluta Strebel, 1906, p. 138, pl. 11, figs. 61, 62 and 64–66.
Natica soluta Strebel, 1908, p. 60.

Type locality. Southern coast of South America.

St. 48. 8·3 miles N 53° E of William Point Beacon, Port William, Falkland Is., 3 May 1926, 105–115 m.
St. 51. Off Eddystone Rock, East Falkland Is., 4 May 1926, 115 m.
St. WS 244. West of Falkland Is., 52° 00′ S, 62° 40′ W, 18 July 1928, 247 m.
St. WS 808. Between Falkland Is. and Patagonia, 49° 40′ 15″ S, 65° 42′ W, 8 Jan. 1932, 109–107 m.
St. WS 817. Between Falkland Is., and Patagonia, 52° 23′ S, 64° 19′ W, 14 Jan. 1932, 191–202 m.

Dentition. Fig. J, 47, p. 192.

Strebel (loc. cit. 1907) subdivided his material, on the size of the umbilical cavity, into forms 'A', 'B' and 'C'. Forms A and C are here covered by *soluta* typical, but form B, which equals Mabille & Rochebrune's *recognita*, I consider to be specifically separable on account of the spreading of the parietal callus pad, which results in the closing of the umbilicus from above and a disproportionate thickening and flexing of the columellar callus.

Falsilunatia recognita (Rochebrune & Mabille)

Natica recognita Rochebrune & Mabille, 1889, p. H 33.

Type locality. Orange Bay, Patagonia, 120 m.

St. WS 766. Between Falkland Is., and Argentina, 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.

Dentition. Fig. J, 48, p. 192. The radula is very similar to that of *soluta*, but presents minor differences in the shape of the central tooth, which is narrower and more acutely arched, and in the laterals, which have a shorter cusp and the addition of several denticles. The inner basal plate of the central tooth is strengthened by two massive vertical processes, which, when viewed laterally, are shown to act as buttresses. The marginals are simple as in *soluta*.

A similar style of central tooth is found in the New Zealand genus *Globisinum* (Powell, 1933, p. 170) (Fig. J, 49) and in *Natica fartilis* Watson (1881), from between Marion Island and Prince Edward Island in 50–140 fathoms.

Apart from radula similarities, *Falsilunatia* differs from *Globisinum* in having an animal that is completely retractive and a smaller, more solid shell. The animal in the New Zealand *G. venustum* Suter resembles that of *Sinum* in being much larger than the shell, but it is not known if an operculum is normally present. The operculum in *Natica fartilis* is shelly.

A third member of *Falsilunatia* appears to be Preston's *Natica falklandica* (1913, p. 218) from Port Stanley, Falkland Islands. It is thin and globose, relatively large and with more elevated spire-whorls than in either *soluta* or *recognita*, but its shape suggests *Falsilunatia* rather than *Globisinum*. Two examples from the British Museum collection were examined (Pl. X, fig. 61). The dimensions of these specimens are respectively: height 17 mm., diameter 14·5 mm.; and height 14·75 mm., diameter 13 mm.

Genus Sinuber n.g.

Type: *Natica sculpta* Martens

The above new genus is provided for small *Sinum*-like species, the true relationship of which is probably with *Polinices* rather than with *Sinum*. The shell is thin, white, with a very inconspicuous epidermis, a transparent, almost colourless film; protoconch smooth and glossy, or with faint spiral lines; post-nuclear sculpture of deeply incised linear grooves; umbilicus narrow and partly bridged, not infilled, by a reflexed columellar callus; columella almost vertical; operculum paucispiral and horny.

The radula is of a style common in the family and similar to that of *Polinices* and *Amauropsis*. Minor differences are that the side cusps of the central tooth are relatively small, the laterals are deeply sinused on their inner edge and bear three weak cusps, while the marginals have simple arcuately pointed, not bifid cusps. It was shown by Troschel (1861, pl. 15, figs. 15, 16) and by Iredale (1924, p. 256) that true *Sinum* has a broad central tooth with the two side cusps more prominent than the central one. The *Sinum*-like genera of *Polinices* affinity—i.e. *Sigaretotrema* Sacco, 1890 (= *Propesinum* Iredale 1924) and *Eunaticina* Fischer, 1885—are not applicable either, for Iredale pointed out (loc. cit.) that their tendency is for the central to become unicuspid.

Sinuber sculpta (Martens)

Natica sculpta Martens, 1878, p. 24.
Natica sculpta Martens & Thiele, 1903, p. 65, pl. 4, fig. 1.

TYPE LOCALITY. Kerguelen I.

Form A. St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.
Form B. St. WS 212. North of Falkland Is., 49° 22′ S, 60° 10′ W, 30 May 1928, 242–249 m.
St. WS 773. North of Falkland Is., 47° 28′ S, 60° 51′ W, 31 Oct. 1931, 291–296 m.

The type locality for *sculpta* is Kerguelen Island, and closely allied forms of it range southward to the Ross Sea and westward to north of the Falklands, South Georgia and South Orkneys.

Unfortunately, I do not have access to topotypic material, and Marten's description is rather lacking in detail. His figure of the holotype, however (1903, pl. 4, fig. 1), and his measurements of the shell, show that the South Orkney-South Georgia form is relatively wider and that the aperture is lower in relation to the height of the shell. This form is described below as a new subspecies.

Ross Sea examples (St. 1660) and those from north of the Falklands (St. WS 212 and WS 773) are small, relatively narrow forms, the former openly umbilicate and the latter with the umbilicus almost closed by the reflexed columellar callus. These two forms exhibit a difference in the number of spiral grooves, but since I cannot make an accurate comparison with *sculpta* on this point, Ross Sea and Falkland material must be tentatively referred to *sculpta*.

Sinuber sculpta scotiana n.subsp., Pl. V, fig. 10

Natica sculpta: Strebel, 1908, p. 62.

This form differs from typical *sculpta*, as shown by reference to Marten's original description and figure, in being relatively wider and with a lower aperture. The protoconch is faintly spirally striate, and there are from sixteen to eighteen linear grooves on the first post-nuclear whorl, twenty on the

penultimate, forty-five moderately widely spaced on the body-whorl, plus a further twenty-five much weaker spirals, which are crowded into the umbilical cavity. Spire about half height of aperture. Umbilicus a narrow pit partially bridged by a thin-edged broadly reflexed columellar lip. Columella vertical, basal section of lip rounded and thickened; outer lip thin.

The differences between the several forms of *sculpta* are best shown in tabular form. (Spirals = number of spiral grooves on the first post-nuclear whorl.)

Height 9·0 mm.; diam. 7 mm.; aperture 7 × 4 mm.; spirals (*sculpta*).
Height 9·5 mm.; diam. 8 mm.; aperture 6·75 × 4·5 mm.; spirals 16–18 (*scotiana*).
Height 9·0 mm.; diam. 7·8 mm.; aperture 6·5 × 4 mm.; spirals 16–18 (*scotiana*).
Height 8·9 mm.; diam. 7·5 mm.; aperture 6·5 × 4 mm.; spirals 16–18 (*scotiana*).
Height 8·5 mm.; diam. 7·2 mm.; aperture 6·0 × 4 mm.; spirals 16–18 (*scotiana*).
Height 6·5 mm.; diam. 5·0 mm.; aperture 4·3 × 2·5 mm.; spirals 12–17 (Form A).
Height 6·3 mm.; diam. 5·0 mm.; aperture 4·5 × 2·5 mm.; spirals 9–12 (Form B).

DENTITION. Fig. J, 50, p. 192. The radula is so minute that it must be almost functionless. The only difference in detail between the radula of *sculpta* (Form, B, St. WS 773) and *scotiana* (St. 167) are that the former has better developed cusps on the laterals and a bifid inner marginal.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m.
St. 167. Off Signy I., South Orkneys, 60° 50′ 30″ S, 46° 15′ 00″ W, 20 Feb. 1927, 244–344 m. (holotype and numerous paratypes).
St. WS 32. Mouth of Drygalski Fjord, South Georgia, 21 Dec. 1926, 225 m.

Genus **Prolacuna** Thiele, 1913.

n.nom. for *Sublacuna* Thiele, 1912 *non* Pilsbry, 1895

Type (o.d.): *Sublacuna indecora* Thiele (= *Frigidilacuna* Tomlin, 1930, another substitute for *Sublacuna* Thiele, 1912)

Prolacuna indecora (Thiele)

Sublacuna indecora Thiele, 1912, p. 195, pl. 12, fig. 4; pl. 15, fig. 19.
Sublacuna indecora Smith, 1915, p. 66.
Sublacuna indecora Eales, 1923, p. 21.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

RANGE. Davis Sea to Ross Sea.

Eales (loc. cit. pp. 21–3) figured the operculum, jaws and radula which, together with general anatomical considerations, show that the genus is Naticoid. It differs from other Naticoids in two unimportant details—the absence of a 'veil' over the snout and the coalescence of the tentacle bases in the mid-dorsal line.

According to Thiele (1912) the genus includes the following three species: *Sublacuna trilirata* Thiele, 1912, Gauss Station; *Lacuna macmurdensis* Hedley (1911) 10–20 fathoms, Cape Royds; and *Lacuna notorcadensis* Melvill & Standen (1907), Scotia Bay, South Orkneys, 9–10 fathoms.

It is doubtful if these heavily spirally keeled species are really congeneric with the smooth *indecora*.

Prolacuna? macmurdensis (Hedley)

Lacuna macmurdensis Hedley, 1911, p. 4, pl. 1, fig. 6.

TYPE LOCALITY. 10–20 fathoms, Cape Royds, Ross Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

Genus Tectonatica Sacco, 1890

Type (monotypy): *Natica tectula* Bonelli, Pliocene, Italy

Tectonatica impervia (Philippi) Pl. X, fig. 62

Natica impervia Philippi, 1845*a*, II, fig. 6.
Natica impervia Hupé (Gay), 1854, p. 221.
Natica impervia Tryon, 1886, p. 31, pl. 9, fig. 66.
Natica impervia Rochebrune & Mabille, 1889, p. H 34.
Natica impervia Strebel, 1906, p. 134, pl. XI, fig. 60.
Natica impervia Strebel, 1908, p. 61.
Natica impervia Melvill & Standen, 1912, no. 18, p. 348.

Type locality. Strait of Magellan.

St. 51. Off Eddystone Rock, East of Falkland Is., 4 May 1926, 105–115 m.
St. 159. Off South Georgia, 53° 52′ 30″ S, 36° 08′ 00″ W, 21 Jan. 1927, 160 m.
St. WS 795. North of Falkland Is., 46° 14′ S, 60° 24′ W, 18 Dec. 1931, 157–161 m.
St. WS 838. Between Falkland Is. and Strait of Magellan, 53° 11′ 45″ S, 65° 00′ 00″ W, 5 Feb. 1932, 148 m.

These shells are characterized by a massive funicle which fills the umbilicus and is defined on its outer edge by a crescentic grove. The operculum is white and calcareous except for a thin horny layer on the inner side. The exterior is smooth, without sulci. The 'Discovery' examples have been compared with Falkland Islands material from the British Museum.

Strebel (1908) described a var. *major* from Paulet Island, 100–150 m., but I have not seen examples.

Dentition. Fig. J, 46, p. 192. The radula conforms in general features with that most commonly found in Naticoids. The central tooth is tricuspid, but the side cusps are much shorter than the central, which reaches right to the basal margin. The laterals have a large centre cusp with a very weak one on each side. The inner marginal is simple, long and slender, the outer shorter, more robust and bifid at the tip, a reversal of the usual arrangement, for in all other instances known to me it is the inner marginal that is the bifid member.

Several authors (Dall, 1892; Woodring, 1928; Finlay & Marwick, 1937) have synonymized *Cryptonatica* Dall, 1892 (type *Natica clausa* Brod. & Sowb.), but the dentition of this Arctic species does not conform with that of *impervia*. In *clausa* (Troschel, 1861, pl. 14, fig. 14), the central has a single large cusp and the marginals are both simple.

Since the radula and opercular features are unknown quantities for the Pliocene genotype of *Tectonatica*, I am at present justified only in disassociating *impervia* from *Cryptonatica*.

Range. Strait of Magellan (type); Tierra del Fuego, 36 m. (Strebel); off Falkland Is., 105–161 m.; Burdwood Bank, Falklands area, 56 fathoms (Melvill & Standen); South Georgia; Paulet I., 100–150 m. (var. *major*).

Family LAMELLARIIDAE

Genus Lamellaria Montagu, 1815

Type: *Lamellaria perspicua* Linn.

Lamellaria patagonica Smith

Lamellaria patagonica Smith, 1881, p. 32, pl. 4, figs. 9, 9*a*, 9*b*.
Lamellaria patagonica Rochebrune & Mabille, 1889, p. H 36.

Type locality. Trinidad Channel, 30 fathoms, Patagonia.

St. 56. Sparrow Cove, Port William, East Falkland Is., 16 May 1926, 10½–16 m.

One example only, easily recognized by the dirty yellow ground colour of the mantle, which is lined and blotched with vandyke brown, as described by Smith.

Lamellaria sp. A

The examples recorded below are probably *L. fuegoensis* Strebel (1906), but owing to hardening of the animal in alcohol and the extreme fragility of the shell I was unable to extract any shells intact.

DENTITION. Fig. J, 53, p. 192. St. WS 867. The central tooth is the characteristic saddle-shape, but the cusps are very poorly developed. The laterals are massive, of typical shape, and bear prominent denticles along the upper and lower cutting edges.

St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.
St. WS 867. Between Falkland Is. and Patagonia, 51° 10′ S, 64° 15·5′ W, 29 Mar. 1932, 137–144 m.

Lamellaria elata Strebel

Lamellaria elata Strebel, 1906, p. 146, pl. 11, fig. 72.

TYPE LOCALITY. Puerto Condor, Patagonia.

St. WS 81. 8 miles N 11° W of North I., West Falkland Is., 19 Mar. 1927, 81–82 m.

DENTITION. Very similar to that of 'sp. A'. Central tooth saddle-shaped with a broad, short, central cusp and five denticles on each side of it. Laterals massive and hooked with prominent denticles along both the upper and lower cutting edges.

Genus **Marseniopsis** Bergh, 1886

Type (Thiele, 1929): *Marseniopsis pacifica* Bergh

Marseniopsis pacifica Bergh

Marseniopsis pacifica Bergh, 1886, p. 19, pl. 1, figs. 7–27.

TYPE LOCALITY. Kerguelen I.

St. 42. Off mouth of Cumberland Bay, South Georgia, 1 Apr. 1926, 120–204 m.
St. 167. Off Signy I., South Orkneys, 60° 50′ 30″ S, 46° 15′ W, 20 Feb. 1927, 244–344 m.
St. 190. Bismarck Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Mar. 1927, 93–130 m.

DENTITION. Formula 2+1+1+1+2. The central tooth is narrow with a deep entire base, not saddle-shaped as in *Lamellaria*, and there is a long, narrow, central cusp with four denticles on each side. The lateral is massive and hooked with four serrations near the lower cutting edge. In addition, there are paired smooth slender marginals. The radula in a St. 190 example is exactly as figured by Bergh.

Unfortunately, the specimens were too contracted and hardened to extract the shell, but since the figured central tooth of both *murrayi* Bergh, 1886, and *conica* Smith (Eales, 1923) are very different in shape and detail, I have no hesitation in assuming that the 'Discovery' material represents Bergh's *pacifica*. Further, the dorsal surface of the animal in the material listed above is covered with depressed, rounded tubercles exactly as in Bergh's description of *pacifica*.

Family TRICHOTROPIDAE

Genus **Antitrichotropis** n.g.

Type: *Trichotropis antarctica* Thiele, 1912

The above new genus is necessary for the Antarctic species recorded below, which differ from the boreal *Trichotropis* in being depressed turbinate and in having simple lateral teeth without denticles.

Antitrichotropis antarctica (Thiele)

Trichotropis antarctica Thiele, 1912, p. 197, pl. 12, fig. 6.
Trichotropis antarctica Smith, 1915, p. 67, pl. 1, fig. 6.
Trichotropis antarctica Hedley, 1916, p. 50.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

RANGE. McMurdo Sound, 300 fathoms (Smith, 1915); Adelie Land, 288 fathoms (Hedley, 1916).

DENTITION. Thiele (1912).

Unfortunately, Melvill & Standen (1912, 26 August) used the same combination '*Trichotropis antarctica*' for a different shell from Burdwood Bank in 56 fathoms, but they subsequently (1916) renamed it *Trichotropis bruceana*. Melvill & Standen's shell is in very poor preservation, and the figure suggests an immature *Trophon* (*Xymenopsis*) rather than a *Trichotropis*.

Antitrichotropis wandelensis (Lamy)

Lacuna wandelensis Lamy, 1907, p. 5, pl. 1, figs. 5–7.
Lacuna wandelensis Melvill & Standen, 1912, p. 349.

TYPE LOCALITY. Wandel I., Palmer Archipelago.

St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 195. Admiralty Bay, King George I., South Shetlands, 62° 07′ S, 53° 28′ 30″ W, 30 Mar. 1927, 391 m.

Only one example from each of the above stations. They are minus the animal, but the epidermis is well preserved and shows odd tufts of hair-like processes disposed at regular intervals on the carinae. Lamy's type is evidently denuded of epidermis.

RANGE. Recorded also from Scotia Bay, South Orkneys, 9–10 fathoms (Melvill & Standen, 1912).

Genus **Trichoconcha** Smith, 1907

Type (monotypy): *T. mirabilis* Smith, 1907

Trichoconcha mirabilis Smith

Trichoconcha mirabilis Smith, 1907, p. 6, pl. 1, figs. 7, 7*b*.
Torellia (*Trichoconcha*) *mirabilis* Thiele, 1912, p. 197.
Torellia (*Trichoconcha*) *mirabilis* Smith, 1915, p. 68.
Trichoconcha mirabilis Hedley, 1916, p. 50.
Trichoconcha mirabilis Eales, 1923, p. 14.

TYPE LOCALITY. Off Coulman I. in 100 fathoms.

St. 123. Off mouth of Cumberland Bay, South Georgia. From 4·1 miles N 54° E of Larsen Point to 1·2 miles S 62° W of Merton Rock, 15 Dec. 1926, 230–250 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia. From 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.
St. 144. Off mouth of Stromness Harbour, South Georgia. From 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.
St. 148. Off Cape Saunders, South Georgia. From 54° 03′ S, 36° 39′ W to 54° 05′ S, 36° 36′ 30″ W, 9 Jan. 1927, 132–148 m.
St. 149. Mouth of East Cumberland Bay, South Georgia. From 1·15 miles N 76½° W to 2·62 miles S 11° W of Merton Rock, 10 Jan. 1927, 200–234 m.

RANGE. Coulman I., Ross Sea (Smith); Commonwealth Bay, 350–400 fathoms; and off Mertz Glacier Tongue, Adelie Land, 157 fathoms; Drygalski I., Davis Sea (Hedley); Gauss Station (Thiele); South Georgia, 122–250 m. ('Discovery').

The 'Discovery' records extend the range of this species to more than half the circumference of the Antarctic continent.

Major diameter 29 mm.; minimum diameter 20·5 mm.; height 19 mm. (holotype).

Major diameter 42 mm.; minimum diameter 31·0 mm.; height 31 mm. (St. 42).

DENTITION. Figured by Eales (1923, loc. cit. p. 15, fig. 12).

Genus **Neoconcha** Smith, 1907

Type (monotypy): *Neoconcha vestita* Smith

Neoconcha vestita Smith

Neoconcha vestita Smith, 1907*a*, p. 6, pl. 1, figs. 11–11*c*.
Neoconcha vestita Smith, 1915, p. 68, pl. 1, fig. 8.
Neoconcha vestita Eales, 1923, p. 11.

TYPE LOCALITY. Off Coulman I., 100 fathoms, Ross Sea.

St. 1652. Ross Sea, 75° 56′ 2″ S, 178° 35′ 5″ W, 23 Jan. 1936, 567 m.

Major diameter 7 mm.; height 8 mm. (holotype).
Major diameter 28 mm.; height 23 mm. (Smith, 1915).
Major diameter 17·5 mm.; height 17 mm. (St. 1652).

DENTITION. Figured by Eales (1923, loc. cit. p. 12, fig. 9).

The buff-coloured epidermis is like a heavy coating of cotton-wool.

Genus **Discotrichoconcha** n.g.

Type: *Discotrichoconcha cornea* n.sp.

This new genus is considered necessary for a small species of the same horny shell substance as *Trichoconcha* but much smaller, paucispiral and discoidal, being vertically compressed like the fresh-water genus *Planorbis*. The few rapidly increasing whorls coupled with the extreme compression of the shell results in a curious broad, very shallow, rectangular aperture.

The only example is too fragile to attempt extracting the animal, which is retracted so much that the operculum is not visible. Its great departure in shape and small size compared with *Trichoconcha* seems to warrant generic separation.

Discotrichoconcha cornea n.sp., Pl. VII, fig. 21

Shell small, horny, discoidal-planorbid, of $2\frac{3}{4}$ whorls, including a blunt, low, rounded, microscopically spirally striated protoconch of one whorl. Spire slightly sunken; umbilicus broad, open, about one-fifth diameter of base, showing all the whorls, even the protoconch. Sculpture consisting of dense arcuate lamellar epidermal processes, each set with numerous short, hair-like filaments. Colour yellowish brown. The aperture is reflected over the parietal wall and slightly dilated all round; the shape is rectangular, about three times wider than high.

Major diameter 5·3 mm.; minimum diameter 4·0 mm.; height 1·7 mm.

TYPE LOCALITY. St. 182. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W, 14 Mar. 1927, 278–500 m. (holotype only).

Family CREPIDULIDAE

Genus **Crepipatella** Lesson, 1831

Type: *Crepidula dilatata* Lamarck

Crepipatella dilatata (Lamarck)

Crepidula dilatata Lamarck, 1822, p. 25.
Crepidula pallida Broderip, 1835, p. 204.
Crypta subdilitata Rochebrune & Mabille, 1889, p. H 37, pl. 4, fig. 11.
Crepidula dilatata Strebel, 1906, p. 166, pl. 12, fig. 87*a*, *b*; pl. 13, figs. 100*a*, *b*, 101*a*, *b*.
Crepidula dilatata Melvill & Standen, 1907, p. 130.
Crepidula dilatata Melvill & Standen, 1914, p. 117.

TYPE LOCALITIES. ? (*dilatata*); Falkland I. (*pallida*); Orange Bay, Patagonia (*subdilitata*).

St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.

Family CALYPTRAEIDAE

Genus **Trochita** Schumacher, 1817

Type: *Patella trochiformis* Gmelin = *Infundibulum* of Tryon, 1886 (*non* Montfort, 1810)*

This genus covers shells with a circular outline, a conical spire with a central nucleus and a moderate sigmoid outline to the edge of the septum. The shape and central position of the nucleus recall both the English *Calyptraea sinensis* Linn. and the New Zealand genus *Zegalerus*. The former, however, has a more elaborate septum which terminates as a tongue forming both a spiral umbilicus and a deep sinus at its outer extremity. In *Zegalerus* the septum is gently concave to almost straight. A second Austro-neozelanic genus, *Sigapatella*, has a simple arcuate septum as in *Zegalerus*, but the shell has more rapidly increasing whorls with the apex off centre (see Fig. E).

The radula of *Trochita trochiformis* (Fig. J, 40) differs from that of *Calyptraea sinensis* (Fig. J, 38) and *Sigapatella terraenovae* (Fig. J, 39) in having a central tooth with a massive cusp and very weak side denticles, and perfectly plain marginals.

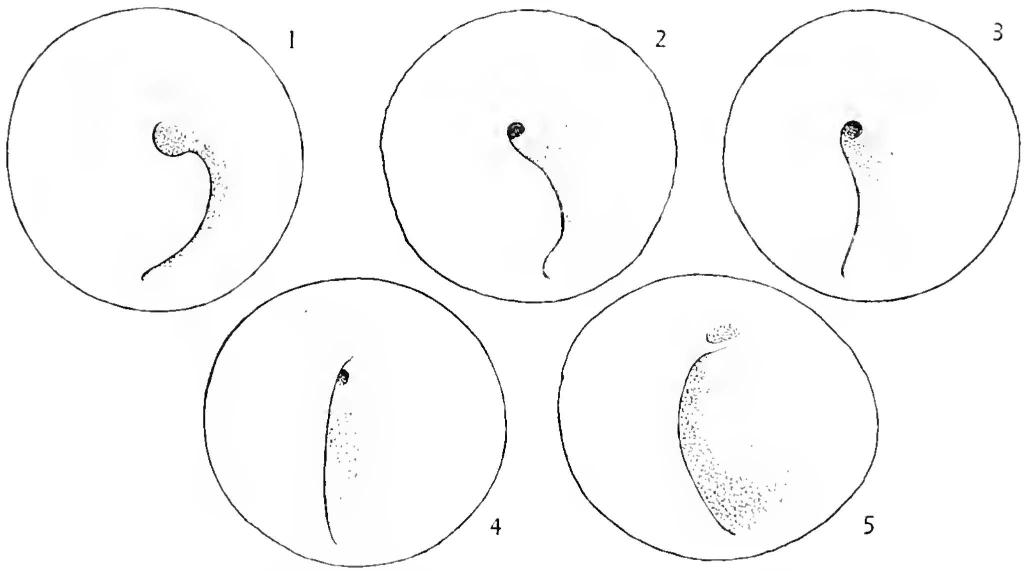

Fig. E. Septa in Calyptraeidae. (1) *Calyptraea sinensis* (Linn.), England. (2) *Trochita trochiformis* (Gmelin), Falkland Is. (3) *Trochita georgiana* n.sp., South Georgia. (4) *Zegalerus tenuis* (Gray), New Zealand. (5) *Sigapatella novaezelandiae* Lesson, New Zealand.

Trochita trochiformis (Gmelin)

Patella trochiformis Gmelin, 1791, p. 3693.
Patella trochiformis Dillwyn, 1817, p. 1018.
Calyptraea radians Lamarck, 1836, p. 626.
Calyptraea costellata Philippi, 1845 *a*, p. 62.
Trochita corrugata Reeve, 1858, fig. 96.
Calyptraea (*Infundibulum*) *radians* Tryon, 1886, p. 121, pl. 35, figs. 84–88.
Calyptraea costellata Strebel, 1906, p. 159, pl. 13, figs. 88–92, 94–97.
Calyptraea costellata Melvill & Standen, 1907, p. 100.
Calyptraea costellata Strebel, 1908, p. 59.

* Montfort's name would undoubtedly have priority if the extremely poor figure of his genotype, '*Infundibulum typus*', was determinable and found to be a Calyptraeid as the figure suggests. Thiele (1929, p. 55) interprets Montfort's *Infundibulum* as a section of *Trochus*.

TYPE LOCALITIES. 'Tranquebar et insulas Falkland' (*trochiformis*); Peru and Chile (*radians*); Patagonia (*costellata*).

St. 51. Off Eddystone Rock, East Falkland Is. from 7 miles N 50° E to 7·6 miles N 63 E of Eddystone Rock, 4 May 1926, 115 m.

St. WS 88. Off Tierra del Fuego, 54° S, 64° 57′ 30″ W, 6 Apr. 1927, 118 m.

St. WS 92. Between Falkland Is. and Patagonia, 51° 58′ 30″ S, 65° 01′ W, 8 Apr. 1927, 145–143 m.

St. WS 841. Burdwood Bank, 54° 11′ 45″ S, 60° 21′ 30″ W, 6 Feb. 1932, 110–120 m.

DENTITION. Fig. J, 40, p. 192. St. WS 92.

Gay (1854, Hupé, p. 232) recognizes both *trochiformis* (= *radians*) and *costellata*, the former with a range from Peru to Chile and the latter in the Strait of Magellan.

If two species are represented, it is important to ascertain the correct type locality for *trochiformis*, which is quoted as 'Tranquebar et insulas Falkland'. Dillwyn's (1817) entry for this species reads 'Inhabits the coasts of the Falkland Islands, Favanne. Tranquebar, Chemnitz'. It seems that the Falklands can be assumed to be the type locality and in order to obviate further confusion I nominate these islands as type locality for the radially ribbed *Trochita* of that area.

Trochita clypeolum Reeve

Trochita clypeolum Reeve, 1859, pl. 3, fig. 14.
Trochita clypeolum Rochebrune & Mabille, 1889, VI, p. 37.
Calyptraea costellata form *clypeolum* Melvill & Standen, 1907, p. 100.
Calyptraea costellata clypeolum Strebel, 1906, p. 159, pl. 13, fig. 93*a*, *b*.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 115 m.

St. 1321. From 4 miles S 72° W to 5·6 miles S 75° W of East Tussac Rock, Cockburn Channel, Tierra del Fuego, 16 Mar. 1934, 66 m.

St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 25 Mar. 1927, 79 m.

St. WS 86. Burdwood Bank, 53° 53′ S, 60° 34′ 30″ W, 3 Apr. 1927, 151 m.

St. WS 92. Between Falkland Is. and Patagonia, 51° 58′ 30″ S, 65° 01′ W, 8 Apr. 1927, 145–143 m.

St. WS 93. 7 miles S, 80° W of Beaver I., West Falkland Is., 9 Apr. 1927, 133 m.

St. WS 97. North-west of Falkland Is., 49° 00′ 30″ S, 61° 58′ W, 18 Apr. 1927, 146 m.

St. WS 214. North of Falkland Is., 48° 25′ S, 60° 40′ W, 31 May 1928, 208 m.

St. WS 221. Off East Patagonia, 48° 23′ S, 65° 10′ W, 4 June 1928, 76 m.

St. WS 231. North of Falkland Is., 50° 10′ S, 58° 42′ W, 4 July 1928, 167–159 m.

St. WS 237. North of Falkland Is., 46° S, 60° 05′ W, 7 July 1928, 150 m.

St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.

St. WS 244. West of Falkland Is., 52° S, 62° 40′ W, 18 July 1928, 253 m.

St. WS 871. North of Falkland Is., from 50° 29′ S, 58° 52′ W to 50° 31′ S, 58° 48′ W, 6 Nov. 1931, 148 m.

St. WS 813. Off East Patagonia, 51° 35′ 15″ S, 67° 16′ 15″ W, 13 Jan. 1932, 106–102 m.

St. WS 818. West of Falkland Is., 52° 30·5′ S, 63° 27′ W, 17 Jan. 1932, 278–285 m.

Trochita georgiana n.sp., Pl. VII, fig. 22

Shell small, white, smooth except for irregular concentric growth wrinkles, and covered with a thin pale buff epidermis which slightly overlaps the peristome. Conical, of circular outline, with the apex almost central. Protoconch of $1\frac{1}{2}$ loosely wound, rapidly increasing whorls, first smooth with a median blunt keel but later developing five spiral ribs, two above and three below the keel. The actual apex is slightly excavated. The protoconch and succeeding whorl form a narrow dome-shaped spire in relation to the last whorl, which is more spread. The shell is very similar to that of *clypeolum* except for the outline of the septum, which is only weakly sigmoid, the outer sinus being only slightly developed. It

approaches the New Zealand genus *Zegalerus*, which is of similar shape but has an even more simplified septum which is merely shallowly concave.

DENTITION. The paired marginals are plain as in *trochiformis*, but the main cusp on both the central and laterals is much weaker.

Height 7·5 mm.; diameter 12·5 mm. (holotype).

TYPE LOCALITY. St. 160. Near Shag Rocks, West of South Georgia, 53° 43′ 40″ S, 40° 57′ W, 7 Feb. 1927, 177 m.

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason Lt., 15 Mar. 1926, 110 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, 23 Dec. 1926, 122–136 m.
St. 152. North of South Georgia, 53° 51′ S, 36° 18′ 30″ W, 17 Jan. 1927, 245 m.
St. 156. North of South Georgia, 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.
St. 159. North of South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.
St. WS 33. Off south end of South Georgia, 54° 59′ S, 35° 24′ W, 21 Dec. 1926, 130 m.

Family STRUTHIOLARIIDAE

Genus **Perissodonta** Martens, 1878

Type (monotypy): *Struthiolaria mirabilis* Smith, 1875, Recent, Kerguelen I.
= *Struthiolarella* Steinmann & Wilckens, 1908

Type (o.d.): *Struthiolaria ameghinoi* v. Ihering, Oligocene, South America

Members of the Struthiolariidae are restricted to southern lands, and their distribution can be accounted for only by an assumed former closer unity of these lands, either in the shape of the early Gondwanaland Continent of geologists, or by an enlarged Antarctica with northern radial extensions.

The family was already well developed in the Upper Cretaceous of both Patagonia and New Zealand in the form of the gerontic genus *Conchothyra*, which shows relationship with the more widely distributed Aporrhaidae.

In the Tertiary the Struthiolariidae were represented in Patagonia by *Struthiolarella* (which seems to equal the Recent *Perissodonta*), in New Zealand by a series of genera, *Monalaria*, *Struthiolaria*, *Callusaria* and *Pelicaria*, and in southern Australia by *Tylospira*.

The distribution of living members of the family is as follows: South Georgia (*Perissodonta*, one species), Kerguelen Island (*Perissodonta*, one species), New Zealand (*Struthiolaria* and *Pelicaria*, one species and a subspecies of each) and south-eastern Australia (*Tylospira*, one species).

Marwick (1924), in his excellent monograph of the Struthiolariidae, referred the Kerguelen species to *Struthiolarella* and omitted reference to Marten's *Perissodonta*. This genus was again overlooked by Finlay & Marwick (1937, p. 15), when a further valuable contribution was made to the phylogeny of the family.

In the light of the adult characteristics of *Perissodonta*, revealed below for the first time by the production of South Georgian examples with a fully grown, deeply sinused peristome, it seems certain that the South American Oligocene? *ornata* (Sowerby) is identical with the recent *P. georgiana*. Both species are presumed to be close to their respective genotypes.

Unfortunately, there are no well-preserved apices in the several South Georgian examples, but opercular and radular characters were noted.

The operculum in *P. georgiana* is elongated leaf-shaped with an attenuated terminal nucleus and a median sharply defined sulcus. In both *Struthiolaria papulosa* and *Pelicaria vermis* the operculum is shaped like a reversed comma, for it is oval, but with a narrow hooked terminal nucleus. In *papulosa* there are several radial planes, but these are ill defined (exaggerated in the text figure) compared with

the deep sulcus in *georgiana*. In *vermis* there are no radial planes, just a slight strengthening rib along the lower inner margin (Fig. N, 120, 121, p. 196).

I have not seen the operculum of *Perissodonta mirabilis*, but Smith's figure (1877, pl. fig. 3*a*) shows a prominent hook, but this may have been due to warping of the operculum in drying and the breaking away of the lower outer margin. However, a significant similarity to the *georgiana* operculum is the median sulcus which is clearly shown in Smith's figure.

Some interesting points arise from study of the dentition of three of the Recent genera: *Struthiolaria*, *Pelicaria* and *Perissodonta* (Fig. I, 35–37, p. 191). First, *Struthiolaria* and *Pelicaria*, as one would expect, show closer alliance to each other than either do to *Perissodonta*, which stands apart by the duplication of its marginals to four or five teeth and the erect, narrowly triangular shape of the laterals as opposed to the rectangular outline of these teeth in both *Struthiolaria* and *Pelicaria*. The triangular-shaped lateral of *Perissodonta* approaches that of *Aporrhais*, and this feature, coupled with that of the deep labial sinus, makes the derivation of the Struthiolariidae from the Aporrhaidae a very reasonable assumption.

Duplication of marginals is evidently an archaic stable feature of *Perissodonta*, for it occurs in the four examples of *georgiana* studied, one of which was prepared by Mr John Morton of Auckland University College, who first drew my attention to this fact. Fischer (1884, Text-fig. 442) gives a curious rendering of the radula of the Kerguelen *P. mirabilis* (as *Struthiolaria costulata* Martens), in which the laterals and marginals are drawn in an unnaturally erect position, but the essential points, five pairs of marginals and tall narrow laterals, are shown.

In *Perissodonta georgiana* all the teeth are denticulate to some degree. The central has blunt, irregular denticles that vary greatly even from tooth to tooth in the same radula. The lateral has a broadly rounded terminal cusp followed by a series of denticles, the innermost marginal is intermediate between the lateral and the slender marginals and bears ten to twelve small but regular denticles, while the outer marginals have only weak serrations towards their blunt, narrowly rounded extremities.

Although both *Struthiolaria* and *Pelicaria* have normal taenioglossid paired marginals and almost identical rectangular laterals, the central tooth is distinctive for each genus. That of *Struthiolaria* is square-based with a multiserrate, broadly triangular cutting edge that does not extend to half the depth of the base. That of *Pelicaria* is oblong, more broad than deep, but has a very large narrowly triangular serrated cusp that extends far below the base. In *Pelicaria* both marginals are plain, but in *Struthiolaria* the inner one is weakly denticulate on its lower inner margin. Unfortunately, the dentition of *Tylospira* is not known.

Perissodonta georgiana Strebel, Pl. VIII, figs. 40–42.

Perissodonta mirabilis georgiana Strebel, 1908, p. 46, pl. 3, figs. 33*a*, *b*, *c*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 252–310 m.

St. 1941. Leith Harbour, South Georgia, 29 Dec. 1936, 38 m.
St. WS 33. Off Southern end of South Georgia, 54° 59′ S, 35° 24′ W, 2 Dec. 1926, 130 m.
St. WS 62. Wilson Harbour, South Georgia, 19 Jan. 1927, 26–83 m.

DENTITION. Fig. I, 35, p. 191, *georgiana*; Fig. I, 36, *Struthiolaria papulosa*, Takapuna, Auckland, New Zealand; Fig. I, 37, *Pelicaria vermis*, Auckland Harbour, New Zealand.

OPERCULUM. Fig. N, 120, *georgiana*; Fig. N, 122, *Struthiolaria papulosa*, Fig. N, 121, p. 196, *Pelicaria vermis*.

Family CYMATIIDAE

Genus Fusitriton Cossman 1903

Type (o.d.): *Triton cancellatum* Lamarck = *Cyrotritonium* Martens 1903, Type *Lampresia murrayi* Smith = *Priene* of Cossmann, 1906, *non* H. & A. Adams, 1858

Fusitriton cancellatum (Lamarck)

Murex magellanicus Chemnitz, 1788, p. 275, pl. 184, fig. 1570 (non binom.).
Triton cancellatum Lamarck, 1822, p. 187.
Triton cancellatum Lamarck, 1845, p. 638.
Fusus cancellatus Reeve, 1848, pl. 16, fig. 62.
Priene magellanica Rochbrune & Mabille, 1889, p. H 42.
Triton cancellatus Strebel, 1905*b*, p. 647, pl. 23, fig. 50*a–e*.
Triton cancellatum (Gay) Hupé, 1854, p. 182.
Triton cancellatus Tryon, 1881, p. 34, pl. 16, fig. 164.

TYPE LOCALITY. Strait of Magellan.

St. WS 71. 6 miles N 60° E of Cape Pembroke Lt., East Falkland Is., 51° 38′ 00″ S, 57° 32′ 30″ W, 23 Feb. 1927, 82–80 m.
St. WS 80. Between Falkland Is. and Patagonia, 50° 58′ 00″ S, 63° 39′ 00″ W to 50° 55′ 30″ S, 63° 36′ 00″ W, 14 Mar. 1927, 152–156 m.
St. WS 83. 14 miles S 64° W of George I., East Falkland Is., 24 Mar. 1927, 137–129 m.
St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 52° 09′ 00″ S, 58° 14′ 00″ W to 52° 08′ 00″ S, 58° 09′ 00″ W, 25 Mar. 1927, 79 m.
St. WS 109. North of Falkland Is., 50° 19′ 00″ S, 58° 27′ 00″ W to 50° 18′ 36″ S, 58° 30′ 00″ W, 26 Apr. 1927, 145 m.
St. WS 225 North-west of Falkland Is., 50° 20′ 00″ S, 62° 30′ 00″ W, 9 June 1928, 162–161 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ 00″ S, 64° 30′ 00″ W, 17 July 1928, 144–141 m.
St. WS 250. North-east of Falkland Is., 51° 45′ 00″ S, 57° 00′ 00″ W, 20 July 1928, 251–313 m.
St. WS 756. North of Falkland Is., 50° 53′ S, 60° 00′ W, 10 Oct. 1931, 118–90 m.
St. WS 799. North-west of Falkland Is., 48° 04′ 15″ S, 62° 48′ 07″ W, 21 Dec. 1931, 141–137 m.
St. WS 804. North-west of Falkland Is., 50° 23·5′ S, 62° 47′ W, 6 Jan. 1931, 143–150 m.
St. WS 866. Between Falkland Is. and Patagonia, 50° 36′ S, 64° 15′ W to 50° 39·5′ S, 64° 15′ W, 29 Mar. 1932, 137–144 m. (juvenile dead shells).
St. WS 867. Between Falkland Is. and Patagonia, 51° 10′ S, 64° 15·5′ W, 30 Mar. 1932, 150–147 m. (half-grown dead shells).
St. 222. St. Martin's Cove, Hermit I., Cape Horn, 23 Apr. 1927, 30–35 m.

RANGE. Magellan and Falkland I. Watson (1886) recorded *cancellatum* from off Marion I., 46° 48′ S, 37° 49′ 30″ E, 69 fathoms. I have not seen this specimen, but it most likely represents a new species.

The finding of numerous examples of this species from a range of stations around the Falkland Islands is of interest, as the species has not hitherto been recorded from this locality. These new records are probably due to the fact that the Discovery Committee's 'William Scoresby' used the otter-trawl extensively in these waters, thus covering a far greater area and securing large, sparsely distributed, species, which previously had only been obtained in small specimen dredges by the merest chance.

The known distribution of the genus is now as follows (See Figs. A and B):

cancellatum (Lamarck 1822): Strait of Magellan; Tierra del Fuego; South Patagonia and Falkland Islands to Patagonia in 30-251 m.;

scaber (King & Broderip, 1831): Valparaiso, 7–45 fathoms to Bolivia (Tryon);

rudis (Broderip, 1833): Chile to Peru (Tryon, Rochebrune & Mabille, 1889);

oregonensis (Redfield, 1848): San Diego, California, Bering Sea and Japan;

murrayi (Smith, 1891): South Africa, off Cape of Good Hope, 150 fathoms and Agulhas Bank, 40 fathoms;

aurora Hedley (1916): Off South Australia, 35° 55′ 30″ S, 134° 18′ 00″ E, 1800 fathoms;

retiolum (Hedley, 1914): Off Green Cape and Gabo Island, New South Wales, Australia, 50–100 fathoms;

laudandum Finlay (1926): New Zealand, Otago Heads, 40 fathoms (type); Auckland Islands; Ninety Mile Beach, North Auckland.

With these additional records for the genus the probable routes of dispersal become more evident. Thus the western coasts of the Americas are considered to have extended the range of this southern genus to the North Pacific via California, Alaska, the Aleutian Chain and thence southward to Japan. The Australian and New Zealand occurrences no doubt had their origin in the Subantarctic rather than as a further southward extension from Japan. The 'Challenger' record ascribed to *cancellatus* from Marion Island is strongly suggestive of the former supposition. This and the South African occurrence indicate an Atlantic-Indian Ocean cross-ridge source which is supported by the recently reported occurrence in South African waters of *Parmaphorella* and *Glypteuthria*, both of which are characteristic Magellan genera (see Tomlin, 1932, pp. 163–4).

THE BUCCINACEA

The whelks are a vigorous, highly plastic group of world-wide range, but especially diversified in the polar regions of both hemispheres.

In 1929 (pp. 57–9) I proposed a classification based largely upon radula and opercula characters, and advocated the use of four families: the Buccinidae, Neptuniidae, Buccinulidae and Cominellidae. Further consideration, however, indicated that the classification I proposed is not nearly so clear-cut as could be desired. Thiele (1929, pp. 305–19) grouped all the genera, covered in the following discussion, in the Buccinidae without the use of either subfamilies or sections.

However, none of the antarctic and subantarctic whelks appears to have much in common with the northern *Buccinum*, which has an ovate operculum with a median submarginal nucleus, and a radula with more than three cusps on both the central and lateral teeth. The southern whelks have the operculum either leaf-shaped with a terminal nucleus or ovate with a paucispiral subterminal nucleus. They appear therefore to be derivatives of the Neptuniidae rather than of the Buccinidae.

Considerable radiation in form has taken place in the southern whelks, making necessary the employment of a series of genera. Not one of these genera, however, is closely similar to *Neptunea*, and I prefer to consider them members of a characteristic southern family, the Buccinulidae. The chief characteristics of the Buccinulidae are the tricuspid central tooth and an operculum with a terminal or subterminal nucleus. Diversity in the form of the lateral teeth, however, suggests the following subfamily grouping:

A. Cominellinae (central tooth tricuspid, lateral teeth bicuspid). *Pareuthria*, *Tromina*, *Notoficula*, *Falsimohnia** and *Glypteuthria*.* Correlatives are *Cominella* and *Fax*, New Zealand and Australia, *Phos*, tropical Pacific and *Searlesia*, North-west America.

B. Buccinulinae (central and lateral teeth tricuspid). *Chlanidota*, *Pfefferia*, *Neobuccinum*, *Probuccinum*, *Cavineptunea* and *Bathydomus*. In the last mentioned, the central tooth has an incipient cusp on each side of the central three and the middle cusp of the laterals is split into two or three small cusps. The sum of characters, however, indicates the genus as a near ally of *Chlanidota*. Correlatives are *Buccinulum*, *Aeneator* and *Verconella*, New Zealand, *Austrosipho* and *Berylsma*, Australia, and *Kelletia*, California.

* In *Falsimohnia* the central tooth has the cusps reduced to one and in *Glypteuthria* a third incipient cusp on the laterals results from bifurcation; otherwise they closely resemble *Pareuthria*.

C. Prosiphiinae (central tooth tricuspid, lateral teeth multicuspid). Typically, the laterals have a long basal projection, like a handle; without this projection but with lateral denticles, in *Proneptunea*; and combining the features of basal projection and lateral denticles, but minus the central tooth in *Meteuthria*, *Prosipho*, *Anomacme*, *Fusinella*, *Meteuthria*, *Proneptunea* and *Chlanidotella*. The *Prosipho* radula, including its variations, does not appear to occur outside Antarctic and Subantarctic seas.

The above arrangement is provisional only and is probably more convenient than real. It is advanced, however, as a step towards the unravelling of the complexity of southern Buccinoid development.

There is no reason why we should look for the origin of these shells from outside the Southern Ocean, for they could have developed in that region concurrently with the northern Buccinidae and Neptuniidae, a common ancestry being assumed in the geological past. It would seem that *Searlesia* (the West American *dira*) and *Kelletia* are both invading Buccinulidae from the south and conversely that the South African *Burnupena* is a true member of the northern Buccinidae.

In this connexion the present distribution of *Fusitriton* demonstrates the effectiveness of the continuity of the Americas with the Scotia Arc, and the Atlantic-Indian Ocean cross-ridge in giving that genus a bipolar circum-Pacific range.

Family BUCCINULIDAE

Subfamily Cominellinae

Genus **Pareuthria** Strebel, 1905

Type (s.d. Tomlin, 1932), *Fusus plumbeus* Philippi

A characteristic Subantarctic and Antarctic genus of small, elongately fusiform shells resembling *Euthria* and *Buccinulum* in shell features, but with bicuspid instead of tricuspid lateral teeth, which feature allies the genus with the Cominellinae. The protoconch is smooth and papillate, of about two whorls, and the operculum is leaf-shaped with a terminal nucleus.

The genus is best developed in the Magellan region, but extends eastwards to Campbell Island, New Zealand, and southwards to the Davis Sea.

Pareuthria fuscata (Bruguière)

Buccinum fuscatum Bruguière, 1789, p. 282.
Buccinum antarcticum Reeve, 1846, fig. 30.
Euthria antarctica Adams, 1858, p. 86.
Tritonium schwartzianum Crosse, 1861, p. 174, pl. 6, figs. 9, 10.
Fusus (Euthria) fuscatus Watson, 1886, p. 209.
Euthria fuscata Strebel, 1905*b*, p. 611, pl. 24, figs. 69–72, 74–79.
Euthria antarctica Lamy, 1905, p. 476.
Euthria fuscata Lamy, 1907, p. 2.
Euthria fuscata Melvill & Standen, 1907, p. 139.
Euthria (Pareuthria) fuscata Strebel, 1908, p. 28.
Euthria (Pareuthria) fuscata Melvill & Standen, 1914, p. 121.

Type localities. ? (*fuscatum*); Falkland Is. (*antarcticum*).

St. 54. Port Stanley, East Falkland Is., 15 May 1926, Shore collecting.
St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 1½ cables N 50° E of Sparrow Point, 16 May 1926, 10½–16 m.
St. 58. Port Stanley, East Falkland Is., 19 May 1926, 1–2 m.

Dentition. Fig. L, 69, p. 194.

Range. Strait of Magellan and Falkland Is.

Pareuthria magellanica (Philippi)

Buccinum magellanicum Philippi, 1848, p. 48, pl. 1, fig. 14.
Fusus rufus Hombron & Jacquinot, 1854, p. 107, pl. 25, fig. 3.
Euthria magellanica Strebel, 1905*b*, p. 601, pl. 24, figs. 57–68, 73.
Euthria magellanica Melvill & Standen, 1907, p. 109.
Euthria magellanica Strebel, 1908, p. 29.
Euthria (Pareuthria) magellanica Melvill & Standen, 1914, p. 121.

TYPE LOCALITY. Strait of Magellan.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.

Strebel (1905) recorded this from Port Stanley, 1 fathom, Falkland Islands and Melvill & Standen (1914) from low water, Roy Cove, Falkland Islands. All the fifty-one 'Discovery' examples are empty shells and may have washed down from shallow waters.

The species is not distinctive and may be only a smooth variation of *fuscata*.

Pareuthria plumbea (Philippi)

Fusus plumbeus Philippi, 1844, p. 108.
Euthria plumbea Strebel, 1905*b*, p. 600, pl. 24, figs. 52–54.
Euthria (Pareuthria) plumbea Strebel, 1908, p. 28.

TYPE LOCALITY. Strait of Magellan.

St. 724. Fortescue Bay, Magellan Strait, 16 Nov. 1931, 0–5 m.

Pareuthria rosea (Hombron & Jacquinot)

Fusus roseus Hombron & Jacquinot, 1854, p. 107, pl. 25, figs. 4, 5.
Euthria rosea Rochebrune & Mabille, 1889, p. 59.
Euthria rosea Strebel, 1905*b*, p. 616, pl. 21, figs. 1–4.
Euthria (Pareuthria) rosea Strebel, 1908, p. 28.
Euthria rosea Melvill & Standen, 1912, p. 355.

TYPE LOCALITY. Strait of Magellan.

St. 48. 8·3 miles N 53° E of William Point Beacon, Port William, Falkland Is., 3 May 1926, 115 m.
St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles, N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.
St. WS 92. Between Falkland Is. and Patagonia, 52° S, 65° W to 51° 57′ S, 65° 02′ W, 8 Apr. 1927, 145–143 m.
St. WS 94. Between Falkland Is. and Patagonia, 50° S, 65° W to 50° 00′ 30″ S, 64° 55′ 30″ W, 16 Apr. 1927, 110–126 m.
St. WS 797. Off Cape Blanco, Patagonia, 19 Dec. 1931, 117 m.
St. WS 867. Between Falkland Is. and Patagonia, 51° 10′ S, 64° 15·5′ W, 30 Mar. 1932, 150–147 m.
St. WS 869. Between Falkland Is. and Patagonia, 52° 15′ 30″ S, 64° 13′ 45″ W, 31 Mar. 1932, 187–201 m.

Pareuthria ringei (Strebel)

Euthria ringei Strebel, 1905*b*, p. 619, pl. 21, fig. 5*a–c*.

TYPE LOCALITY. Strait Le Maire, between Staten I. and Tierra del Fuego.

St. 388. Between Cape Horn and Staten I., 56° 19½′ S, 67° 09¾′ W, 16 Apr. 1930, 121 m. (numerous well-preserved empty shells).
St. WS 86. Burdwood Bank, south of Falkland Is., 53° 53′ 30″ S, 60° 34′ 30″ W, 3 Apr. 1927, 151 m.

RANGE. Also recorded by Strebel (1905, loc. cit.) from Puerto Gallegos, east coast of Patagonia.

Pareuthria michaelseni (Strebel)

Euthria michaelseni Strebel, 1905*b*, p. 621, pl. 21, fig. 6*a*, *b*.
Euthria michaelseni Melvill & Standen, 1907, p. 109.
Euthria (Pareuthria) michaelseni Strebel, 1908, p. 28.
Euthria (Pareuthria) michaelseni Melvill & Standen, 1914, p. 121.

TYPE LOCALITY. Smyth Channel, Strait of Magellan.

St. WS 71. 6 miles N 60° E of Cape Pembroke, Lt., East Falkland Is., 51° 38′ S, 57° 32′ 30″ W, 23 Feb. 1927, 82 m.
St. WS 80. North-west of Falkland Is., 50° 58′ S, 63° 39′ W to 50° 55′ 30″ S, 63° 36′ W, 14 Mar. 1927, 152–156 m.
St. WS 88. Off Tierra del Fuego, 54° S, 65° W to 54° S, 64° 55′ W, 6 Apr. 1927, 118 m.
St. WS 97. North-west of Falkland Is., 49° S, 62° W to 49° 01′ S, 61° 56′ W, 18 Apr. 1927, 146–145 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.
St. WS 804. North-west of Falkland Is., 50° 22′ 45″ S, 62° 49′ W, 6 Jan. 1932, 143–150 m.

This is a slender, finely striated shell of light chestnut colour, relieved by a narrow white peripheral band on the body-whorl.

Pareuthria paessleri (Strebel)

Euthria paessleri Strebel, 1905*b*, p. 625, pl. 21, fig. 9*a*, *b*.

TYPE LOCALITY. Smyth Channel, Strait of Magellan.

St. WS 834. Near eastern entrance to Strait of Magellan, 2 Feb. 1932, 27–28 m.

This species has a distinct submargined suture and spiral striations on the base only.

Pareuthria scalaris (Watson)

Fusus (Sipho) scalaris Watson, 1882, p. 377.
Fusus (Neptunea) scalaris Watson, 1886, p. 203, pl. 12, fig. 5.
Probuccinum scalare Thiele, 1912, p. 263.

TYPE LOCALITY. 47° 48′ 30″ S, 70° 47′ W, north-west Patagonia, 125 fathoms.

St. WS 80. North-west of Falkland Is., 50° 57′ S, 63° 37′ 30″ W, 14 Mar. 1927, 152–156 m.
St. WS 237. North of Falkland Is., 46° S, 60° 05′ W, 7 July 1928, 150–256 m.
St. WS 804. North-west of Falkland Is., 50° 22′ 45″ S, 62° 49′ W, 6 Jan. 1932, 143–150 m.

Pareuthria venustula n.sp., Pl. VI, fig. 17

Shell narrowly fusiform with a tall spire and short canal, very thin, semi-transparent, dull white and without colour markings. Whorls 6½, moderately convex but slightly excavated below the suture. Protoconch smooth and glossy, papillate of 2½ whorls, the apex flattened, tilted and slightly immersed. Post-nuclear whorls delicately and densely spirally lirate, eighteen to twenty-six lirations on the spire-whorls and about fifty-two on the body-whorl. There are numerous slightly sinuous and irregularly disposed axial growth lines. The neck of the canal is smooth except for weak axial growth lines. Spire one and a third times height of aperture plus canal. Aperture simple without internal lirations or denticles. Outer lip thin. Basal sinus broad and shallow.

Height 13·3 mm.; diameter 5·9 mm. (holotype).

TYPE LOCALITY. St. 388. Between Cape Horn and Staten I., 56° 19½′ S, 67° 09″ W, 16 April 1930, 121 m. (one living example and several well-preserved empty shells).

DENTITION. Fig. L, 70, p. 194. Typical, with tricuspid central and bicuspid lateral teeth.

Genus Tromina Dall, 1918

Type (o.d.): *Fusus unicarinatus* Philippi, Strait of Magellan

This generic name was provided on the basis of a few empty shells from the Strait of Magellan in 20 fathoms, and although comparisons with the Neptuniidae were made by Dall (1902) he considered the genus to be Trophonoid (Dall, 1902*b*, p. 536).

In 1925 Dall (pl. 21, fig. 7) figured the species for the first time, showing a strongly keeled shell very similar to a new species from Clarence Islands, 61° 25′ 30″ S, 53° 46′ W, which proves to be Cominellid close to *Parenthria*.

These shells have a relatively large, dome-shaped protoconch with a smooth, blunt nucleus, but later developing brephic axial threads and fine spiral striae. The operculum is horny, ovate and paucispiral, occupying about half the area of the aperture, and the radula has a tricuspid central tooth and bicuspid laterals. The radula resembles that of *Parenthria* except for the form of the laterals, which have the cusps set closer together, the inner one massive and incurved. A similar style of radula occurs in the species *Notoficula problematica* n.sp., described following.

I have included in *Tromina* a group of smaller Magellan species with rounded whorls and numerous regular spiral cords, crossed by weak axial threads, but they lack the prominent keels of both the genotype and the Clarence Island *tricarinata*. The protoconch, operculum and radula, however, are similar to those features in the typical species, Fig. N, 103, 126, p. 196.

Tromina tricarinata n.sp., Pl. X, figs. 64, 65

Shell small, dull white, biconic, the body-whorl with three strong spiral keels. Whorls five, including a large, blunt, dome-shaped protoconch of two whorls, the first smooth and almost flat-topped, the second with numerous fine crisp axial threads and dense microscopic spiral striae. First post-nuclear whorls with a prominent, bluntly rounded, median keel, the penultimate with a second keel emergent at the lower suture and the body-whorl with three keels. Outline of shell strongly concave on the shoulder, between the keels and below the lowest keel on the base. Surface delicately reticulated by dense axial and spiral threads. The spirals, which are slightly stronger than the axials, number about fourteen on the shoulder of the body-whorl, five on the rounded keels, nine to eleven between the keels and about thirty below the lowest keel. Spire less than height of aperture plus canal. Aperture produced below into a short open spout-like canal. Outer lip thin, columella strongly incurved above and spirally flexed below. Operculum small, occupying about half the area of the aperture, ovate, thin, horny and paucispiral, the nucleus subterminal and on the inner side.

Height 13·5 mm.; diameter 8·5 mm.

Type locality. St. 170. Off Cape Bowles, Clarence Is., 61° 25′ 30″ S, 53° 46′ W, 23 Nov. 1927, 342 m.

Dentition. Fig. L, 71, p. 194.

Tromina fenestrata n.sp., Pl. VI, fig. 14

Shell small, white, squat, sculptured with numerous sharply raised spiral cords, crossed by fine, crisp, axial threads which render the cords weakly gemmulate. Whorls weakly shouldered by an extra strong cord situated just above the middle, $4\frac{1}{2}$, including a large dome-shaped protoconch of $1\frac{1}{2}$ whorls, smooth at first, but the last half-whorl with closely spaced minute axial threads and indistinct spirals. All spire-whorls with six narrow, sharply raised spiral cords, number three from the top the strongest and forming the peripheral angulation. Body-whorl with twenty spiral cords, more closely spaced over the middle of the base, and including five on the neck. The axial threads number about forty-five on the

body-whorl, and in addition there is an interstitial surface sculpture of dense microscopic axial threads. Aperture as in the other species except for a peripheral angulation of the outer lip.

The epidermis is so thin and transparent that it is scarcely apparent. Operculum ovate, paucispiral, occupying slightly more than half the area of the aperture.

Height 6·0 mm.; diameter 4·0 mm. (holotype).

TYPE LOCALITY. St. WS 766. Between Falkland Is. and Argentina, 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.

Tromina bella n.sp., Pl. VI, fig. 16

Shell small, ovate, squat, with broadly rounded whorls, evenly sculptured with moderately strong rounded spiral cords and covered with a thin, pale buff epidermis. Whorls $4\frac{1}{2}$, including a blunt, dome-shaped protoconch of $1\frac{1}{2}$ whorls, the tip smooth, followed by a whorl of weak axial threads, becoming more distinct over the last half-whorl which has the addition of weak spiral threads. First and second post-nuclear whorls with seven rounded spiral cords, penultimate with eight and body-whorl with about thirty, ten of which are on the neck. The whole surface is crowded with dense axial threads which render weakly gemmulate some of the spiral cords of the shoulder. Aperture ovate-pyriform with a short open canal. Outer lip thin, columella straight medially and spirally flexed below. Parietal callus weak, shining white with the spiral sculpture showing through towards the outer edge. Operculum ovate, paucispiral, occupying about half the area of the aperture.

Height 7·4 mm.; diameter 5·0 mm. (holotype, St. 817).

TYPE LOCALITY. St. WS 817. Between Falkland Is. and Patagonia, 52° 28′ S, 64° 19′ W, 14 Jan. 1932, 191–202 m.

St. WS 212. North of Falkland Is., 49° 22′ S, 60° 10′ W, 30 May 1928, 242–249 m.
St. WS 244. West of Falkland Is., 52° S, 62° 40′ W, 18 July 1928, 253–247 m.
St. WS 816. Between Falkland Is. and Patagonia, 52° 09′ 45″ S, 64° 56′ W, 14 Jan. 1932, 150 m.
St. WS 818. Between Falkland Is. and Patagonia, 52° 31′ 15″ S, 63° 25′ W, 17 Jan. 1932, 272–278 m.

DENTITION. Fig. L, 72, p. 194 (St. WS 818). PROTOCONCH. Fig. N, 104, p. 196.

Tromina simplex n.sp., Pl. VI, fig. 15

Shell small, ovate, squat with lightly convex whorls sculptured with dense spiral threads. Whorls $4\frac{1}{2}$, including a blunt dome-shaped protoconch of $1\frac{1}{2}$ whorls, smooth at first but sculptured with closely spaced axial and spiral threads over the last half-whorl. First and second post-nuclear whorls with ten spiral threads, penultimate with sixteen and body-whorl plus neck with about fifty. Surface crowded with very weak axial growth lines. Aperture ovate-pyriform with a short open canal. Outer lip thin. Columella straight medially and spirally flexed below. Parietal callus smooth, sharply marked off from the sculptured body-whorl.

Height 7·25 mm.; diameter 4·25 mm. (holotype, St. WS 237).

TYPE LOCALITY. St. WS 237, north of the Falkland Is., 46° S, 60° 05′ W, 7 July 1928, 150–256 m.

St. WS 216. North of the Falkland Is., 47° 37′ S, 60° 50′ W, 1 June 1928, 219–133 m.

The species is easily distinguished from *bella* by its much less inflated sagging whorls and much finer and denser spiral sculpture. No living examples were obtained, but the style of apex renders reference to *Tromina* almost certain.

Genus **Notoficula** Thiele, 1917

n.nom. for *Ficulina* Thiele, 1912, non Gray, 1867

Type: *Ficulina bouveti* Thiele

Thiele (1912, p. 270, pl. 19, fig. 13) based this genus upon a small 'Ficus'-shaped shell from Bouvet Island, which he first placed subgenerically under *Cominella* and later (1929, p. 315) as a section of *Chlanidota*.

Living examples, possibly not fully adult, of what appears to be an allied species are described below. If my reference of these shells to *Notoficula* is correct, then that genus is indicated as allied to *Pareuthria* and quite close to *Tromina*. These shells have a tricuspid central tooth and bicuspid laterals, but the laterals are distinct from those of *Pareuthria* in that the two cusps are set much closer together and the inner one is the more robust. Also the inner cusp is strongly incurved with a deeply concave inner margin. The protoconch is dome-shaped and smooth, and the operculum ovate to D-shaped, paucispiral, with the nucleus near to the lower inner margin, Fig. N, 125.

Notoficula problematica n.sp., Pl. VI, fig. 18

Shell small, ovate, white, few whorled, surface regularly incised with spiral linear grooves. Whorls $3\frac{3}{4}$, including a relatively large, smooth, dome-shaped protoconch of $1\frac{3}{4}$ whorls. Spire less than half height of aperture. Sculpture of post-nuclear whorls in the form of regularly spaced linear grooves, which cut the surface into low, flat-topped spiral cords, nine on the penultimate and about thirty on the body-whorl. The whole surface is crossed by dense axial threads, more conspicuous in the grooves. Aperture ovate-pyriform, outer lip thin with a broad open anterior canal, neither produced nor sinused, but partially constricted by a callused fold at the base of the pillar. Parietal wall deeply concave medially, but not excavated, covered with a thin callus. Operculum much smaller than the aperture, horny, ovate to D-shaped, paucispiral, the nucleus near to the lower inner margin.

Height 5·25 mm.; diameter 3·6 mm. (holotype).

Height 6·9 mm.; diameter 5·0 mm. (St. WS 766, a worn shell, probably adult).

TYPE LOCALITY. St. WS 766. Between Falkland Is. and Argentina, 45° 13′ S, 59° 56′ 30″ W, 18 Oct. 1931, 545 m.

DENTITION. Fig. K, 61, p. 193. OPERCULUM. Fig. N, 125, p. 196.

The material upon which this species is based may not be fully adult, but it is certainly distinct from the larger *bouveti*, which is of more pyriform outline and has less conspicuous spiral sculpture.

Genus **Falsimohnia** n.g.

Type: *Buccinum albozonatum* Watson

This genus has a dentition of similar style to that of the Boreal genus *Mohnia* Friele, 1878, but on shell characters the relationship is much more in accord with *Pareuthria* or *Glypteuthria*. Both *Mohnia* and *Falsimohnia* have the central tooth with a single cusp and bicuspid laterals. The reduction of the cusps of the central tooth to a single member also occurs in the Mediterranean *Chauvetia* (= *Lachesis* Risso), and this fact no doubt influenced Martens & Thiele in their placing of *Lachesis australis* (1903, p. 62).

I would consider *Falsimohnia* as a derivative of *Pareuthria* in which the normal three cusps of the central tooth have been reduced to a single member. There is a parallel case in the Naticoid genus *Tanea*, which has a central tooth with only one cusp, whereas most other genera of the family are tricuspid. Also the operculum of *Falsimohnia* has a blunt terminal nucleus as in *Pareuthria*, whereas in *Mohnia* it is ovate and paucispiral.

Falsimohnia albozonata (Watson)

Buccinum albozonatum Watson, 1882, p. 358.
Buccinum albozonatum Watson, 1886, p. 212, pl. 13, fig. 7.
Mangelia antarctica Martens & Pfeffer, 1886, pl. 1, figs. 5*a*, *b*.
Lachesis? australis Martens & Thiele, 1903, p. 62, pl. 5, fig. 18.
Pareuthria albozonata Thiele, 1912, p. 244.
Pareuthria albozonata L. David, 1934, p. 128.

TYPE LOCALITIES. Royal Sound, Kerguelen I., 28 fathoms (*albozonatum*); South Georgia (*antarctica*); Kerguelen I. (*australis*).

St. 123. Off mouth of Cumberland Bay, South Georgia, from 4·1 miles N 54° E of Larsen Point to 1·2 miles S 62° W of Merton Rock, 15 Dec. 1926, 230–250 m.

St. 140. Stromness Harbour to Larsen Point, South Georgia, from 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.

St. 149. Mouth of Cumberland Bay, South Georgia, from 1·15 miles N 76½° W to 2·62 miles S 11° W of Merton Rock, 10 Jan. 1927, 200–234 m.

St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.

DENTITION. Fig. K, 59 (St. 149); Fig. K, 60, p. 193 (after Marten's (1903) for *Lachesis? australis*).

OPERCULUM. Fig. N, 127, p. 196.

The shallow-water St. WS 25 example has the typical colour pattern—brownish with a median pale spiral band, but material from the deeper water stations is uniformly buff.

Genus **Glypteuthria** Strebel, 1905

Type (s.d. Tomlin 1932): *Euthria meridionalis* Smith

The shells of this genus differ from those of *Pareuthria* in having more obvious sculpture, composed of equally well-developed spiral and axial ribs. Thiele (1929, pp. 311–18) associated *Glypteuthria* and *Probuccinum*, but disassociated them from *Pareuthria*, which he made a subgenus of *Northia*. I cannot understand Thiele's action in doing this, for there is no evidence against the view that *Glypteuthria* is a strongly sculptured relative of *Pareuthria*, apart from the fact that the lateral teeth in *Glypteuthria* are not strictly bicuspid. In *Pareuthria* the laterals are bicuspid, but in *Glypteuthria meridionalis* bifurcation of the inner cusp results in a third incipient cusp, but this condition is not comparable with that of *Probuccinum*, in which there are three strongly developed and evenly spaced cusps.

The distribution of *Glypteuthria*, previously considered Magellanic, is now known to extend to South African waters, i.e. *capensis* (Thiele, 1925, p. 179) *capensis** and *solidissima* (Tomlin, 1932, pp. 164–7). The Magellan species are *meridionalis* Smith, 1881, *kobelti* Strebel, 1905, and *acuminata* Smith, 1915.

Glypteuthria meridionalis (Smith)

Euthria meridionalis Smith, 1881, p. 29, pl. 4, fig. 6.
Euthria meridionalis Rochebrune & Mabille, 1889, p. 61.
Euthria (*Glypteuthria*) *meridionalis* Strebel, 1905*b*, p. 627, pl. 21, fig. 11*a*, *b*.
Glypteuthria meridionalis Thiele, 1912, pl. 13, fig. 6 and pl. 16, fig. 17.

TYPE LOCALITY. Portland Bay, St Andrew's Sound, 10 fathoms, Patagonia.

St. WS 834. Near eastern entrance to Strait of Magellan, 2 Feb. 1932, 27–38 m.

DENTITION. Fig. K, 58, p. 193 (after Thiele, 1912, loc. cit.).

* Renamed *Glypteuthria sculpturata*, Tomlin (1945).

Subfamily BUCCINULINAE

Genus **Chlanidota** Martens, 1878

Type (monotypy): *Cominella (Chlanidota) vestita* Martens, Kerguelen Island

The genus is restricted to the Antarctic region, with a known range extending over the Weddell, Enderby and Victoria quadrants. Only one species, the genotype, extends to as far north as the Antarctic Convergence.

The shell is very thin and is covered with a pilose epidermis. Anterior canal truncated, deeply notched, with a ridge-margined fasciole. Operculum disproportionately small for the size of the aperture, irregularly ovate, horny, excentric, with the nucleus at the anterior margin (Figs. F and N, 129).

The radula is very uniform; it has a tricuspid central tooth with a broad excavated basal plate and a tricuspid lateral on either side of it. Specific differentiation is most clearly shown in the respective shapes of the central tooth. The tricuspid laterals have the central cusp weak and situated close alongside the inner cusp suggesting bifurcation of the inner of two original cusps. However, the three lateral cusps are now so stable a feature that *Chlanidota* is more naturally placed with the Buccinulinae than with the Cominellinae. In fact *Chlanidota*, *Neobuccinum* and the next genus, *Pfefferia*, may well represent a transitional stage between the short canalled Cominellids and the long canalled Buccinulids.

Reference to the Buccinidae is even less appropriate as shown by radula and opercular characters as well as from geographical considerations.

Chlanidota vestita (Martens)

Cominella (Chlanidota) vestita Martens, 1878.
Chlanidota vestita Tryon, 1881, p. 201, pl. 79, fig. 391.
Neobuccinum vestitum Watson, 1886, p. 216.
Chlanidota vestita Smith, 1902, p. 203.
Cominella (Chlanidota) vestita Martens & Thiele, 1903, p. 63.
Cominella (Chlanidota) vestita Lamy, 1911*a*, p. 63.

TYPE LOCALITY. Kerguelen Island, Subantarctic.

RANGE. Subantarctic, Kerguelen I., 88 m. (Martens); Antarctic, Cape Adare, 24–26 fathoms (Smith). I have been unable to check the Cape Adare record with material.

Chlanidota pilosa n.sp., Pl. VIII, figs. 29 and 30

Compared with the South Georgian *densesculpta*, the Bouvet Island species is more globose, the spire more depressed (telescoped) and the shoulder quite distinctive in being noticeably inrolled to a more deeply incised suture. The sculpture also is more pronounced, consisting of less dense but stronger spiral threads.

Shell thin and fragile, white, covered with a light yellowish brown epidermis which develops dense short bristles on all the spiral treads. Spire short, depressed, dome-shaped, 0·37 height of aperture. Twenty-one narrow, crisp spiral threads on penultimate and about fifty-seven on body-whorl. Spiral sculpture weakly concellated by closely spaced finer axial threads. In *densesculpta* there are from thirty to thirty-six spiral threads on the penultimate. Anterior canal deeply notched. Fasciole well defined by arcuate growth lines, but not ridge-margined above as in *densesculpta*.

Height 25·5 mm.; diameter 20 mm. (St. 456, holotype *pilosa* n.sp.)
Height 34·5 mm.; diameter 24 mm. (holotype of *densesculpta*).
Height 30·0 mm.; diameter 20 mm. (St. 1941, *densesculpta*).

DENTITION. Fig. L, 73, p. 194. The radula is very similar to that of *densesculpta* except that the cusps of the central tooth are closer together, more broadly triangular and the middle one is much larger than the other two.

OPERCULUM. Typical, horny, small for size of aperture, irregularly ovate, flattened along the lower or anterior edge which is the nucleus. Aperture of shell 3·3 times height of operculum.

TYPE LOCALITY. St. 456. 1 mile east of Bouvet I., 18 Oct. 1930, 40–45 m. (one living example, the holotype, and one empty shell).

Chlanidota densesculpta (Martens) Pl. VIII, figs. 31–33

Cominella (Chlanidota) densesculpta Martens, 1885, p. 91.
Cominella (Chlanidota) densesculpta Martens & Pfeffer, 1886, p. 71, pl. 1, fig. 3*a–f*.
Chlanidota densesculpta Strebel, 1908, p. 33.
Chlanidota densesculpta David, 1934, p. 128.

The species is quite variable in shape as shown by the following dimensions:
Height 31·0 mm.; diameter 20 mm. (Martens & Pfeffer).
Height 34·5 mm.; diameter 24 mm. (Martens & Pfeffer holotype).
Height 30·0 mm.; diameter 21 mm. (St. 1941), Pl. VIII, fig. 31.
Height 30·0 mm.; diameter 18 mm. (St. WS 62), Pl. VIII, fig. 32.
Height 40·0 mm.; diameter 23 mm. (St. WS 62), Pl. VIII, fig. 33.

DENTITION. Fig. L, 75, p. 194. The radula is most like that of *pilosa* n.sp.

TYPE LOCALITY. South Georgia.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m.
St. 141. East Cumberland Bay, South Georgia, 200 yards from shore under Mt. Duse, 29 Dec. 1926, 17–27 m.
St. 145. Stromness Harbour, South Georgia, between Grass I. and Tonsberg Point, 7 Jan. 1927, 26–35 m.
St. 1941. Leith Harbour, South Georgia, 29 Dec. 1936, 55–22 m.
St. WS 62. Wilson Harbour, South Georgia, 19 Jan. 1927, 15–45 m. and 26–83 m.
St. MS 6. East Cumberland Bay, ¼ mile south of Hope Point to 1¼ cables S × E of King Edward Point Lt., 12 Feb. 1925, 24–30 m.
St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, 14 Feb. 1925, 26–18 m.

RANGE. Antarctic; South Georgia 0–270 m.; south-west of Snow Hill I., 64° 36′ S, 57° 42′ W, 125 m. (Strebel, 1908). *Note:* Marten's 1903 Bouvet I. record of *densesculpta* is Thiele's *Notoficula bouveti* (Thiele, 1912).

Chlanidota elongata (Lamy)

Cominella (Chlanidota) vestita var. *elongata* Lamy, 1910*b*, XVI, p. 319.
Cominella (Chlanidota) vestita var. *elongata* Lamy, 1911*a*, p. 6, pl. 1, fig. 6.

TYPE LOCALITY. Off King George I., South Shetlands, 420 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 60° 28′ 00″ W, 23 Feb. 1927, 342 m.
St. 175. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 1952. Between Penguin I. and Lion's Rump, King George I, South Shetlands 11 Jan. 1937, 367–383 m.
St. 1957. Off South Side of Clarence I., South Shetlands, 7 miles east of Cape Bowles, 3 Feb. 1937, 785–810 m.

RANGE. Antarctic; South Shetlands, 200–810 m.

DENTITION. Fig. L, 76, p. 194.

Chlanidota signeyana n.sp., Pl. VIII, figs. 34, 35

The species is closely allied to the South Shetlands *elongata* but is constantly broader and of ovate rather than cylindrical outline.

Shell thin and fragile, white, covered with a thin, pale buff epidermis. Spire tall for the genus, 0·56 height of aperture. Whorls sculptured with moderately strong but narrow sharply raised spiral cords, ten to eleven on penultimate and twenty-three to twenty-six on the body-whorl, plus a few weak intermediates. Surface crossed by dense exceedingly fine axial growth lines. Anterior canal deeply notched; fasciole margined above by a sharply raised narrow ridge.

Height 38 mm.; diameter 24·5 mm. (holotype).
Height 32 mm.; diameter 21·0 mm. (paratype).
Height 29 mm.; diameter 19·0 mm. (paratype).
Height 32 mm.; diameter 19·0 mm. (*elongata*, St. 1952).
Height 28 mm.; diameter 16·5 mm. (*elongata*, St. 1952).

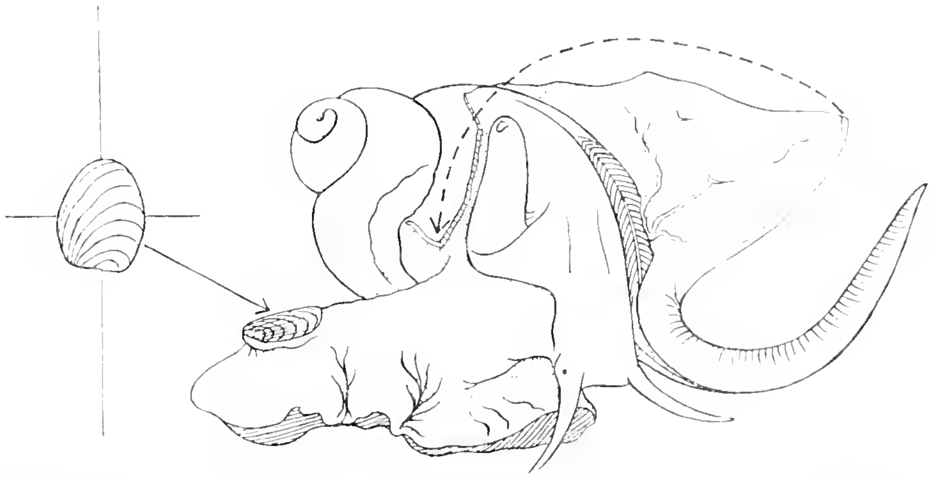

Fig. F. *Chlanidota signeyana*, n.sp. View of the whole animal with the mantle cut and folded back. Note the vestigial operculum, in relation to the size of the aperture (shown by crossed lines to the left).

DENTITION. Fig. L, 74, p. 194. OPERCULUM. Fig. N, 129, p. 196. The central tooth has a wide but comparatively shallow base, deeply excavated below.

ANIMAL. The external features of the animal are shown in Fig. F.

TYPE LOCALITY. St. 167. Off Signy I., South Orkneys, 60° 50′ 30″ S, 46° 15′ 00″ W, 20 Feb. 1927, 244–344 m.

St. 162. Off Signy I., South Orkneys, 60° 48′ 00″ S, 46° 08′ 00″ W, 17 Feb. 1927, 320 m.

Chlanidota paucispiralis n.sp., Pl. VIII, figs. 36, 37

Shell small, thin and fragile, narrowly ovate, white, covered with a thin buff epidermis. Spire tall for the genus, 0·6 height of aperture. Whorls sculptured with a few wide-spaced prominent but narrow, sharply raised, spiral ridges, four on penultimate and eleven on the body-whorl. Surface crossed by dense, exceedingly fine axial growth lines. Anterior canal deeply notched; fasciole not margined above by a ridge.

Height 22·1 mm.; diameter 13·5 mm. (holotype).

DENTITION. Fig. L, 77, p. 194. The radula is almost identical with that of *elongata*.

OPERCULUM. Typical, horny, ovate, with apical nucleus; very small. Aperture of shell 3·6 times height of operculum.

TYPE LOCALITY. St. 159. South Georgia, 53° 52′ 30″ S, 36° 08′ 00″ W, 160 m.

St. 157. Off South Georgia, 53° 51′ 00″ S, 36° 11′ 15″ W, 20 Jan. 1927, 970 m.
St. 158. Off South Georgia, 53° 48′ 30″ S, 35° 57′ 00″ W, 21 Jan. 1927, 401–411 m.

?Chlanidota gaini (Lamy)

Sipho gaini Lamy, 1910*b*, p. 319.
Sipho gaini Lamy, 1911*a*, p. 7, pl. 1, figs. 7, 8.
Prosipho? gaini Thiele, 1912, p. 262.

TYPE LOCALITY. Off King George I., South Shetlands, 420 m.

This species, known to me only by Lamy's figure of the damaged holotype, seems to be a very narrow, produced-spired *Chlanidota*. The thin shell, style of sculpture, and columellar twist recall *Chlanidota*, also the large size (33 × 12 mm.) suggests this genus rather than *Prosipho*, the members of which are quite small. Hedley (1916) suggested relationship between *Sipho gaini* and his *Pontiothauma ergata*, but that seems unlikely also.

Genus **Pfefferia** Strebel, 1908
Type (here designated): *Pfefferia palliata* Strebel
South Georgia, non *Pfeifferia* Gray, 1853

The genera *Chlanidota* and *Pfefferia*, as already explained, appear to be transitional between the Cominellinae and the Buccinulinae. In *Chlanidota* the shell is very thin, the operculum disproportionately small for the size of the aperture, and the lateral teeth of the radula are tricuspid. In *Pfefferia* the shell is much stouter, the operculum almost fills the aperture, is of peculiar form, with a heavy ridged outer margin, and the lateral teeth of the radula are tricuspid also. In *Cominella* the operculum is relatively large and ovate, with an apical nucleus, but no margining ridge and the lateral teeth of the radula are bicuspid.

The genus *Pfefferia* is known only from deep water off South Georgia.

Pfefferia elata Strebel

Pfefferia elata Strebel, 1908, p. 35, pl. 3, fig. 40.

TYPE LOCALITY. South Georgia, 54° 17′ S, 36° 28′ W, 75 m.

St. 30. West Cumberland Bay, South Georgia, 2·8 miles S 24° W of Jason Lt., 16 Mar. 1926, 251 m.

Height 34·5 mm.; diameter 23·5 mm. (St. 30).
Height 31·0 mm.; diameter 21·0 mm. (St. 30).

DENTITION. Fig. L, 78, p. 194. The radula is abnormal in the only specimen, for there are two additional incipient cusps and they are situated one on each side of the normal group of three cusps on the central tooth.

OPERCULUM. Fig. N, 128, p. 196. Typical, horny, leaf-shaped, with apical nucleus and a very massive, raised, striated border along the entire outer margin. Aperture of shell 1·3 times height of operculum.

RANGE. South Georgia, 75–251 m.

Pfefferia cingulata Strebel

Pfefferia cingulata Strebel, 1908, pl. 3, figs. 42*a–c*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 252–310 m.

St. 146. Off South Georgia, 53° 48′ 00″ S, 35° 37′ 30″ W, 8 Jan. 1927, 728 m.
St. 158. Off South Georgia, 53° 48′ 30″ S, 35° 57′ 00″ W, 21 Jan. 1927, 401–411 m.

Height 21·3 mm.; diameter 14 mm. (St. 146, young example).

DENTITION. Fig. L, 79, p. 194. The central tooth has three strong equally developed cusps and a deeply excavated base. Laterals with a tall slender incurved outer cusp and a shorter truncated, heavy inner cusp, plus a small narrow middle cusp situated close alongside the inner cusp.

OPERCULUM. Typical, horny, narrowly ovate, with apical nucleus and thickened margining ridge along the upper part of the outer edge. In the other species of the genus this margining ridge extends along the entire outer margin. Aperture 1·6 times height of operculum (Strebel, 1908, pl. 3, fig. 42*b*).

RANGE. South Georgia, 75–728 m.

The following two species complete the known members of the genus.

Pfefferia palliata Strebel

Pfefferia palliata Strebel, 1908, p. 34, pl. 3, fig. 39*a–f*.
Pfefferia palliata Thiele, 1912, pl. 16, fig. 20 (radula).

TYPE LOCALITY. South Georgia, 54° 17′ S, 36° 28′ W, 75 m.

Pfefferia chordata Strebel

1908. *Pfefferia chordata* Strebel, *Schwed. Sudpol. Exped.* VI (1), pl. 3, fig. 41*a–c*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 252–310 m.

Genus **Neobuccinum** Smith, 1877

Type (monotypy): *Neobuccinum eatoni* Smith

Neobuccinum eatoni (Smith)

Buccinopsis eatoni Smith, 1875, p. 68.
Neobuccinum eatoni Smith, 1879, p. 169, pl. 9, figs. 1, 1*a*.
Neobuccinum eatoni Studer, 1879, p. 129.
Neobuccinum eatoni Watson, 1886, p. 216.
Neobuccinum eatoni Smith, 1902, p. 202.
Neobuccinum eatoni Thiele, 1903, p. 168, pl. 9, fig. 57.
Neobuccinum eatoni Lamy, 1906*b*, p. 2.
Neobuccinum eatoni Smith, 1907*a*, p. 1.
Neobuccinum eatoni Melvill & Standen, 1907, p. 139.
Neobuccinum praeclarum Strebel, 1908, p. 31, pl. 3, fig. 38.
Neobuccinum eatoni Lamy, 1910*b*, p. 199.
Neobuccinum eatoni Lamy, 1911*a*, p. 5.
Neobuccinum eatoni Hedley, 1911, p. 6, pl. 1, figs. 11, 12.
Neobuccinum eytoni Thiele, 1912, p. 211.
Neobuccinum eatoni Smith, 1915, p. 72.
Neobuccinum eatoni Lamy, 1915, p. 69.
Neobuccinum eatoni Hedley, 1916, p. 59, pl. 9, fig. 97.
Neobuccinum eatoni Eales, 1923, p. 28.

TYPE LOCALITIES. 3–7 fathoms Royal Sound, Kerguelen I. (*eatoni*); Graham Land, 64° 3′ S, 56° 37′ W, 360 m. (*praeclarum*).

St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m.
St. 1644. Bay of Whales, 78° 24·8′ S, 164° 10·3′ W, 16 Jan. 1936, 626 m.
St. 1952. Between Penguin I. and Lion's Rump, King George I., South Shetlands, 11 Jan. 1937–383 m.

RANGE. Graham Land (Strebel); South Orkneys (Melvill & Standen); South Shetlands (Lamy); McMurdo Sound and Commonwealth Bay (Hedley); Ross Sea (Smith) and Kerguelen Island (Smith).

Hedley (1916, loc. cit. p. 59) was apparently quite correct in placing *praeclarum* in the synonym of *eatoni*. I cannot find any valid points of difference in this variable species.

DENTITION. Eales (1923) figured the radula of an example from McMurdo Sound in 20 m. and noted that it showed characters intermediate between *Buccinum* and *Cominella*.

The radula is decidedly more in accord with that of *Cominella* than with that of *Buccinum*, for it has a tricuspid central and although the inner cusp of the laterals is incised to form several weak cusps this tooth is still basically bicuspid. The boreal *Buccinum* on the other hand has six cusps on the central and four on the laterals. The operculum also conforms more to that of *Cominella* than to that of *Buccinum*. In *Cominella* and *Neobuccinum* the operculum has a terminal nucleus whereas in *Buccinum* it is median submarginal with concentric growth lines.

Genus Probuccinum Thiele, 1912

Type (o.d.): *Neobuccinum tenerum* Smith

This is an Antarctic and Subantarctic *Buccinulum*-like group characterized by a thin, semi-transparent shell, ovate operculum with a small paucispiral terminal nucleus, and a radula with both the central and lateral teeth tricuspid.

The following species were ascribed to the genus by Thiele (1912, loc. cit.): *Neobuccinum tenerum* Smith, 1907, Coulman Island, 100 fathoms; *Probuccinum costatum* Thiele, 1912, Gauss Station, Davis Sea; *Fusus* (*Neptunea*) *regulus* Watson, 1882, Kerguelen I., 28 fathoms; *Fusus* (*Neptunea*) *edwardiensis* Watson, 1882, between Marion I. and Prince Edward I., 140 fathoms; and *Fusus* (*Neptunea*) *scalaris* Watson, 1882, north-west Patagonia, 125 fathoms. The latter, however, seems to be a *Pareuthria*.

Hedley (1916) added a further species in *Probuccinum tenuistriatum* from the D'Urville Sea in 157 fathoms, and Tomlin (1948) recorded *tenerum* from 69 m. off Macquarie I.

Probuccinum delicatulum n.sp., Pl. VII, fig. 28

Shell ovate-fusiform, truncated below, thin, semi-transparent, white, covered with a very thin pale buff epidermis. Whorls six, including a large, smooth, dome-shaped protoconch of $2\frac{1}{2}$ whorls. Post-nuclear sculpture of weak, very numerous, dense spiral striations crossed by crowded, somewhat irregular, faint, crisp, axial growth lines. There are about thirty-two spirals on the antepenultimate and about forty-five at the close of the penultimate whorl. The axial growth lines are nowhere strong enough to assume the role of axial ribs, and a casual impression is that the shell is smooth. Spire about one and an eighth times height of aperture. Aperture obliquely D-shaped; outer lip thin, steeply descending from the suture, effuse below the middle and flattened basally, with a broad, very shallow anterior notch. In profile the outer lip is slightly insinuated just below the suture. Columella and parietal wall with an evenly arcuate, narrow, thinly glazed callus. Operculum horny, ovate, with a small, paucispiral, apical nucleus, Fig. N, 123.

Height 20·5 mm.; diameter 10·5 mm. (holotype).

Height 16·0 mm.; diameter 8·0 mm. (St. 160).

TYPE LOCALITY. St. 140. Stromness Harbour to Larsen Point, South Georgia, from 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.

St. 159. Off South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.

St. 160. Between South Georgia and Shag Rocks, 53° 43′ 40″ S, 40° 57′ W, 7 Feb. 1927, 177 m.

DENTITION. Fig. K, 63, p. 193 (holotype). Compared with Thiele's figure of the radula of *tenerum* (Fig. K, 64) the central tooth is proportionately wider, not sinused at the base, and the three cusps are of equal size, not with the central one stronger.

OPERCULUM. Fig. N, 123, p. 196.

The species is nearest allied to *Probuccinum tenuistriatum* Hedley (1916, p. 58, pl. 8, figs. 95, 96). Compared with the South Georgian species, *tenuistriatum* is proportionately wider and has the addition of a varix near the outer lip.

Probuccinum angulatum n.sp., Pl. VII, fig. 27

Shell broadly conical with a sharply angled periphery on the last whorl; smooth, except for weak irregular axial growth folds; white, covered with a thin, pale buff epidermis. Protoconch conical, erect, of $2\frac{3}{4}$ smooth whorls with a bluntly rounded tip. The holotype has two post-nuclear whorls but is evidently not adult. Operculum horny ovate-pyriform, slightly produced on the lower inner edge and with a terminal nucleus.

TYPE LOCALITY. St. 156. North of South Georgia, 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.

St. 159. North of South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.

Height 9·9 mm.; diameter 7·0 mm. (holotype).

DENTITION. Fig. K, 65, p. 193. St. 159. Unfortunately, the only example containing the animal has an abnormal radula with five cusps on the left lateral and four on the right. The central is of similar shape to that of *delicatulum*, but it also is abnormal in having an additional weak cusp between the central cusp and the right-hand outer one.

This species is of heavier build than *delicatulum*, and although the material is not adult the species will be easily recognized by its strong peripheral angulation.

Genus **Cavineptunea** n.gen.

Type: *Cavineptunea monstrosa* n.sp.

This genus is provided for a *Neptunea*-like shell with a remarkable protoconch, quite unlike any other I have seen. It is large, like a tall, spirally wound collar, and surrounds a deep apical cavity. The nucleus is small and central, and the spiral collar emerges from it with rapidly increasing whorls. The effect is definitely neither the result of erosion nor the loss of a prior horny envelope. A juvenile in a perfectly non-eroded state has a protoconch of exactly the same form. The operculum is irregularly ovate with a blunt terminal nucleus, and the radula consists of a tricuspid central tooth and three or four cusps on the laterals. A similar abnormality is shown in Troschel & Thiele's figure of the radula of *N. bulbacea* (1868, pl. 6, fig. 16) which has three cusps on one lateral and four on the other. Unfortunately, I was able to prepare only one radula mount, so the normal number of lateral cusps is in doubt.

The shell is tall-spired, with a short, twisted canal and an angulate periphery.

It is difficult to determine whether *Cavineptunea* is an Antarctic relative of the Neptuniidae or simply another example of the adaptive radiation so marked in the Cominellid-Buccinuloid assemblage of the southern regions, but the latter supposition is the more likely. Unfortunately, the only available animal was not well enough preserved to do more than examine the dentition.

Cavineptunea monstrosa n.sp., Pl. VIII, figs. 38, 39

Shell thin, white, with a film of yellowish buff epidermis. Spire tall, $1\frac{2}{5}$ times height of aperture; base concave, strongly contracted; pillar flexuous. Whorls seven, including a relatively large concave protoconch of about $2\frac{1}{2}$ whorls, with a tall, straight-sided spiral rim, as described above. The first whorl of the protoconch is smooth, but the second develops closely spaced, weak, flattened spiral cords, and the carinate edge rapidly resolves into one of these spirals as the coiling becomes normal with steep straight-sided whorls. First post-nuclear whorl with ten flattened linear spaced spiral cords, penultimate with sixteen, and body whorl, including base, with thirty-eight. Aperture obliquely pyriform;

outer lip thin, straight in profile and obliquely retractive to the axis. Parietal wall deeply excavated. Pillar flexuous and strongly recurved, but the end is broken in the only near adult specimen, so the length of the anterior canal is not known. It cannot be very long, however, judging by the strongly reflexed pillar.

Height 36 mm. (actual), 38 mm. (estimated); diameter 18 mm.

LOCALITIES. St. 159. Off South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m. (holotype).

St. 160. Between South Georgia and Shag Rocks, 53° 43′ 40″ S, 40° 57′ W, 7 Feb. 1927, 177 m. (two juveniles).

DENTITION. Fig. K, 68, p. 193 (St. 159). PROTOCONCH. Fig. N, 105, p. 196.

Subfamily PROSIPHIINAE

Genus **Prosipho** Thiele, 1912

Type (s.d. Thiele 1929): *Prosipho gaussianus* Thiele

Prosipho astrolabiensis (Strebel)

Sipho (?*Mohnia*) *astrolabiensis* Strebel, 1908, p. 31, pl. 3, figs. 37*a–d*.
Prosipho astrolabiensis Thiele, 1912, p. 262.

TYPE LOCALITY. Astrolabe I., 63° 9′ S, 58° 17′ W, 95 m.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, 23 Dec. 1926, 122–136 m.
St. 144. Off mouth of Stromness Harbour, South Georgia, 5 Jan. 1927, 155–178 m.
St. 190. Bismarck Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Mar. 1927, 93–130 m.
St. WS 27. Off South Georgia, 53° 55′ S, 38° 01′ W, 19 Dec. 1926, 107 m.

RANGE. Palmer Archipelago to South Georgia, 95-279 m. Melvill & Standen's record (1912) of *crassicostatus* from Burdwood Bank, 56 fathoms, requires confirmation.

Melvill & Standen (1912, p. 355) made this species a synonym of their *Chrysodomus* (*Sipho*) *crassicostatus*, described in 1907 (p. 138) from Scotia Bay, South Orkneys, 9–10 fathoms, off weed and stones. Thiele (1912) recognized both as distinct species of *Prosipho*.

I have not seen shallow-water examples comparable with *crassicostatus*, which from Melvill & Standen's figures appears to have coarser spirals and one less on the penultimate and body-whorl than in *astrolabiensis*.

This species and the next, *chordatus* Strebel, are very similar in size, build and sculpture, so much so that they are separable only with difficulty, yet the radulae differ considerably.

Both have a long basal outer extension of the laterals, like a handle, a peculiar feature of *Prosipho*, but *astrolabiensis* is bicuspid, whereas in *chordatus* the laterals fan out above and have six cusps. All the *Prosipho* radulae figured by Thiele (1912) have more than two cusps: *similis*, *glacialis*, *pusillus*, *nodosus*, *gaussianus* and *certus*. The central in all the species is narrow and deep based, more or less rectangular and with three cusps.

RADULA. Fig. K, 56, p. 193.

Prosipho chordatus (Strebel)

Sipho? *chordatus* Strebel, 1908, p. 30, pl. 2, fig. 29*a–c*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 252–310 m.

St. 123. Off Cumberland Bay, South Georgia. From 4·1 miles N 54° E of Larsen Point to 1·2 miles S 62° W of Merton Rock, 15 Dec. 1926, 230–250 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, 23 Dec. 1926, 122–136 m.
St. 152. Off South Georgia, 53° 51′ 30″ S, 36° 18′ 30″ W, 17 Jan. 1927, 245 m.
St. 156. Off South Georgia, 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.

RANGE. South Georgia, 122–310 m.

Although they are of similar size and colour *chordatus* can be always distinguished from *astrolabiensis* by the number of spiral cords which range, as the whorls increase, from two to four in *astrolabiensis* and four to six in *chordatus*. If Melvill & Standen's figures of *crassicostatus* are correct, their species shows the spiral cords increasing from two to three. The cords in *astrolabiensis* are narrower and more sharply raised than in *chordatus*.

RADULA. Fig. K, 55, p. 193.

Prosipho hunteri Hedley

Prosipho hunteri Hedley, 1916, p. 56, pl. 8, fig. 92.

TYPE LOCALITY. Commonwealth Bay, Adelie Land, 25 and 45–50 fathoms.

St. 140. Stromness Harbour to Larsen Point, South Georgia, 23 Dec. 1926, 122–136 m.
St. 152. Off South Georgia, 53° 51′ 30″ S, 36° 18′ 30″ W, 17 Jan. 1927, 245 m.

These 'Discovery' records extend the range of this species to the opposite side of the Antarctic Continent. Although I have not seen actual topotypes, the South Georgia examples compare exactly with Hedley's description and excellent figure.

Height 6·0 mm.; diameter 3·0 mm. (holotype).
Height 6·0 mm.; diameter 3·0 mm. (St. 152).
Height 6·5 mm.; diameter 3·1 mm. (St. 140).

Prosipho cancellatus Smith

Prosipho cancellatus Smith, 1915, p. 71, pl. 1, fig. 13.

TYPE LOCALITY. Ross Sea, 76° 56′ S, 164° 12′ E, 160 fathoms.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan 1936, 351 m.

The shell figured by Smith (loc. cit. pl. 2, fig. 15) from 'off Rio de Janeiro in 40 fathoms' appears to be correctly identified, but the locality is certainly incorrect, as Smith suspected.

Prosipho contrarius Thiele

Prosipho contrarius Thiele, 1912, p. 209, pl. 13, fig. 1.

TYPE LOCALITY. Gauss Station.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

Prosipho perversus n.sp., Pl. VI, fig. 11

This species is very similar to *contrarius*, but it is smaller and has more prominent spiral keels, which increase to four instead of three over the last two whorls. Whorls 4½, including a narrowly conic smooth protoconch of 1 whorl, which has an asymmetric nucleus. First and second post-nuclear whorls with three well-developed spiral keels, penultimate with a fourth emergent from the lower suture and body-whorl with four strong, equally developed keels. There are four spiral cords on the neck and these are almost as strong as the keels. In *contrarius* there are seven comparatively weak cords on the neck.

Height 4·0 mm.; diameter 2·0 mm. (*perversus*).
Height 4·6 mm.; diameter 2·3 mm. (holotype of *contrarius*).
Height 5·6 mm.; diameter 2·7 mm. (*contrarius*, St. 1660).

TYPE LOCALITY. St. 144. Off mouth of Stromness Harbour, South Georgia. From 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan 1927, 155–178 m. (one example, the holotype).

Prosipho madigani Hedley

Prosipho madigani Hedley, 1916, p. 56, pl. 8, fig. 93.

TYPE LOCALITY. 25–50 fathoms, Commonwealth Bay, Adelie Land.

St. 182. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W, 14 Mar. 1927, 278–500 m.

This sole example measures 10·5 × 4·9 mm. and has $5\frac{1}{2}$ whorls, compared with 13·5 × 4·3 mm. and six whorls for Hedley's type. Hedley's measurements are evidently incorrect, however, for the figure shows proportions and sculptural detail in accord with the St. 182 specimen.

The above new record extends the range of the species to the opposite side of the Antarctic Continent. It is of interest also to note that Tomlin (1948, p. 229) has recently recorded the species from Macquarie Island, which is considerably north of the type locality and just outside the Antarctic convergence.

DENTITION. Fig. K, 54, p. 193. The laterals resemble those of *astrolabiensis*, but the basal plate is more produced and there are three cusps instead of two.

Genus **Anomacme** Strebel, 1905

Type (monotypy): *Anomacme smithi* Strebel

The genotypes of both *Antistreptus* (Dall, 1902*b*, p. 532) and *Anomacme* are superficially very similar, apart from the fact that the former is sinistral. The apices are different, however, that of *Anomacme* being decidedly Trophonoid in its asymmetric elongated and almost straight-sided whorls. The radula of *A. smithi*, however (Thiele 1912, pl. 16, fig. 14), is similar to that of *Prosipho*, for the laterals have the basal plate produced into long narrow process resembling a handle. Unfortunately, the dentition of *Antistreptus magellanicus* is not known, so for the present it is not advisable to follow Thiele (1929, p. 318) in closely associating *Antistreptus* and *Anomacme*.

Anomacme smithi Strebel

Anomacme smithi Strebel, 1905*b*, p. 633, pl. 22, fig. 28*a–e*.
Anomacme smithi Thiele, 1912, pl. 13, fig. 8 and pl. 16, fig. 14.
Antistreptus (*Anomacme*) *smithi* Thiele, 1929, p. 318.

TYPE LOCALITY. Smyth Channel, Strait of Magellan.

St. 388. Between Cape Horn and Staten I., 56° $19\frac{1}{2}$′ S, 67° $09\frac{3}{4}$′ W, 16 Apr. 1930, 121 m. (one empty shell).

DENTITION. Fig. K, 57, p. 193 (after Thiele, 1912).

Strebel's *Glypteuthria contraria* (1908, pl. 1, fig. 4) is a synonym of *Antistreptus magellanicus* Dall (1902).

Genus **Meteuthria** Thiele, 1912

Type (o.d.): *Euthria martensi* Strebel

Although *martensi* appears to be a heavily sculptured *Pareuthria*, comparable with *Glypteuthria*, the dentition indicates closer relationship with *Proneptunea*. Both have triangular or fan-shaped laterals, the top slope with from four to six cusps and the outer edge with a series of denticles. In *Meteuthria* only the laterals are present, but *Proneptunea* has the addition of a tricuspid central tooth.

Thiele (1929, p. 317) included the Antarctic *Chlanidotella*, *Proneptunea* and *Meteuthria* as subgenera of *Thalassoplanes*, a tropical mid-Pacific genus from 2463 fathoms.

The genotype of *Meteuthria* has a conical protoconch of $2\frac{1}{2}$ whorls, the tip smooth, small and projecting, followed by a whorl of closely spaced, thin, crisp axials and the remainder reticulated by axials and somewhat stronger spirals. Other members of the genus are Watson's *Fusus* (*Sipho*) *futile* from between Kerguelen and Heard Islands in 150 fathoms (Watson, 1886) and *Euthria* (*Glypteuthria*) *agnesia* Strebel (1905) from Strait of Magellan.

In *Glypteuthria* the protoconch consists of a relatively large, mammillate, smooth, brownish apex of $1\frac{1}{2}$ whorls followed by a brephic reticulated stage.

Meteuthria martensi (Strebel)

Euthria (*Glypteuthria*) *martensi* Strebel, 1905*b*, p. 630, pl. 21, fig. 13*a*, *b*.
Meteuthria martensi Thiele, 1912, p. 243, pl. 13, fig. 7 and pl. 16, fig. 18.

TYPE LOCALITY. Smyth Channel, 10 fathoms, Strait of Magellan.

St. 388. Between Cape Horn and Staten I., 56° 19½′ S, 67° 09¾′ W, 16 Apr. 1930, 121 m. (empty shells only).

DENTITION. Fig. K, 62, p. 193 (after Thiele, 1912).

Genus **Proneptunea** Thiele, 1912

Type (o.d.): *Fusus* (*Troschelia*?) sp. Martens & Thiele, 1903 = *Proneptunea amabilis* Thiele, 1912

The shells of this genus are small, fusiform, with a thick brownish epidermis and are sculptured with prominent spiral keels. The protoconch is relatively large, paucispiral with straight sides, slightly concave on top and with an inrolled nucleus. The operculum is horny, irregularly ovate-quadrate, with a terminal nucleus. The radula consists of a deep and narrow-based tricuspid central and quadrate laterals with five well-formed cusps on the upper edge and a series of small denticles down the outer margin.

Martens and Thiele's *Fusus* (*Troschelia*?) sp. and Thiele's *Proneptunea amabilis*, both from Kerguelen Island and acknowledged to be identical by Thiele (1912), have this same style of dentition.

Proneptunea fenestrata n.sp., Pl. VI, fig. 12

Shell small, fusiform, with a thick yellowish brown epidermis, prominently sculptured with heavy spiral keels and interstitial thin axial lamellae. Whorls five including a relatively large paucispiral erect protoconch of $1\frac{1}{2}$ straight-sided whorls inrolled at the tip, leaving an apical depression. Spire slightly taller than height of aperture plus canal. Spire whorls bearing two very prominent keels, the uppermost, which defines a broad, almost flat shoulder, becoming bifid at the commencement of the penultimate whorl. Body-whorl with the addition of a third prominent keel at the top of the aperture and three much weaker spirals on the base. The shoulder, the interspaces and base crossed by regular crisp axial epidermal lamellae, twenty-one on the penultimate and twenty-nine on the body-whorl. Aperture approximately ovate-pyriform, deeply grooved on the inside, corresponding to the external keels. Outer lip deeply scalloped between the keels, but bridged by the lamellae. Anterior canal short, oblique, and spirally twisted, causing a prominent fasciole which is crossed transversely by a concentration of the terminals of the lamellate processes. In some examples the bifid peripheral keel shows the lamellae in the interspace, but on the crest of the keels the lamellae are scarcely apparent. Operculum irregularly ovate-quadrate, with a terminal nucleus.

Height 12·0 mm.; diameter 6·6 mm. (holotype, St. 141).

TYPE LOCALITY. St. 141. East Cumberland Bay, 200 yards from shore, under Mt Duse, South Georgia, 29 Dec. 1926, 17–27 m.

St. 140. Stromness Harbour to Larsen Point, South Georgia, from 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.
St. 145. Stromness Harbour, between Grass I. and Tonsberg Point, South Georgia, 7 Jan. 1927, 26–35 m.
St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.
St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, South Georgia, 14 Feb. 1926, 26–18 m.

DENTITION. Fig. K, 67, p. 193 (St. 141). PROTOCONCH and OPERCULUM. Fig. N, 106, 124, p. 196.

Proneptunea duplicarinata n.sp., Pl. VI, fig. 13

Shell small, fusiform, thin, covered with a pale yellowish brown epidermis, prominently sculptured with heavy spiral keels, the main ones divided into two or three by linear grooves, and crossed by distant fringe-like axial epidermal processes. Whorls five, including a relatively large, smooth, paucispiral protoconch of two straight-sided whorls, the top concave, oblique, with a slightly inrolled nucleus. Spire slightly less than height of aperture plus canal. First post-nuclear whorl sculptured with three prominent spiral keels, the uppermost, at about three-fourths whorl height, defining a broad, slightly concave shoulder. Second post-nuclear whorl with both the uppermost and lowest keels bifid and penultimate with the uppermost and lowest trifid and the middle one bifid. Body-whorl with the same development as the penultimate plus another bifid keel, level with the top of the aperture, six simple, widely spaced spirals on the base and neck, and six closely spaced, weak spiral cords on the fasciole. Axials in the form of fringe-like epidermal lamellate processes, eleven per whorl. The lamellae are regularly deeply scored, causing them to split into a series of moderately long, narrow tags. Aperture broadly ovate but produced below into a relatively long, obliquely recurved anterior canal. Outer lip thin, corrugated by the external sculpture and deeply spirally scored within.

Height 17·0 mm.; diameter 7·0 mm.

TYPE LOCALITY. St. 160. Between South Georgia and Shag Rocks, 53° 43′ 40″ S, 40° 57′ W, 7 Feb. 1927, 177 m.

DENTITION. Fig. K, 66, p. 193.

Genus **Chlanidotella** Thiele, 1929

Type (monotypy): *Cominella modesta* Martens

Chlanidotella modesta (Martens)

Cominella modesta Martens, 1885, p. 91.
Cominella modesta Martens & Pfeffer, 1886, p. 73, pl. 1, fig. 4*a–e*.
Chlanidota modesta Strebel, 1908, p. 33.
Thalassoplanes (*Chlanidotella*) *modesta* Thiele, 1929, p. 317.
Chlanidota (*Chlanidotella*) *modesta* David, 1934, 2–3, p. 128.

TYPE LOCALITY. South Georgia.

St. WS 56. Larsen Harbour, Drygalski Fjord, South Georgia, 14 Jan. 1927, 2 m.
St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, 14 Feb. 1925, BTS, 26–18 m.

RANGE. South Georgia, 0–18 m.

DENTITION. Fig. L, 80, p. 194. The laterals bear four cusps, evidently the result of regular bifurcation of an original two. The central tooth has the usual three cusps of the family, but the basal plate is deeper than in either *Chlanidota* or *Pfefferia*. The operculum has a terminal nucleus.

Family MURICIDAE

The dentition of the southern Trophons does not present any clear-cut types. In fact, the radulae of both the Muricidae and the Thaisidae conform remarkably to a single type which presents only minor variations. The protoconch, however, clearly divides the southern Trophons into two main groups: (1) with a paucispiral asymmetrical nucleus and (2) with a polygyrate conical nucleus.

The Trophons are members of the Muricidae because they have an operculum with a terminal or subterminal nucleus and a rounded, not flattened or excavated columella. The members of the Thaisidae, on the other hand, have an operculum with a lateral nucleus and the columella is definitely flattened to excavated. Muricids are mostly lightly built with lamellate to spinose sculpture and a long anterior canal. Thaisids, on the other hand, are usually solid, ovate, with rugged sculpture and relatively short anterior canal.

That the Muricids and Thaisids are more closely interrelated than is generally supposed would seem to be indicated by the dentition. On shell and opercular characters there is little to distinguish the South Georgian *Trophon shackletoni paucilamellatus* from the Magellanic *T. laciniatus*, but whereas the former has a radula typical of most Trophons that of the latter closely agrees with the rather distinctive type found in the Thaisid genus *Stramonita* and also in certain of the *Drupa*-like genera. The similarity would appear to be too strong to be accounted for by mere coincidence. This type of radula differs from that of the remaining members of the family in having well-developed denticles along the outer edge of the side cusps of the central tooth.

I am not suggesting that on the one-sided evidence of the radula only one family should be admitted, for it seems that the characters of both the operculum and the columella afford a satisfactory differentiation that is in accord with general shell characters.

It is yet to be satisfactorily explained to what extent the radula can become modified to suit different feeding methods. In cases where a shellfish, presumed to have been an active feeder, has developed a ciliary method, the response appears to be a reduction of the radula to vestigial and functionless size rather than a radical change in the form and arrangement of the teeth. This has apparently occurred in *Trophon echinolamellatus* (described below), a shell of equal size to that of the genotype, *Trophon geversianus*, but with a radula that is many times smaller than that of the second named species.

Genus Trophon Montfort, 1810

Type (o.d.): *Trophon magellanicus* Gmelin (=*geversianus* Pallas)

The genus *Trophon* is well developed in the southern ocean and has its counterpart in *Boreotrophon* of Arctic and North Temperate seas. Typical *Trophon* has a large globose thin shell with prominent axial lamellae and a smooth paucispiral asymmetrical protoconch. The radula consists of a central tooth with an L-shaped lateral on each side. The central tooth is broad and shallow with three main cusps and two intermediates. Operculum horny, ovate with a terminal nucleus.

Trophon geversianus (Pallas)

Buccinum geversianus Pallas, 1769, p. 33, pl. 3, fig. 1.
Murex magellanicus Gmelin, 1792, p. 3548, no. 80 (excl. var. B).
Murex magellanicus Dillwyn, 1817, p. 725.
Murex lamellosus Dillwyn, 1817, p. 730.
Murex magellanicus Wood, 1818, p. 132, pl. 26, fig. 90.
Murex patagonicus, *magellanicus* and *varians* d'Orbigny, 1841, pp. 451–4.
Trophon geversianus Gould, 1852, p. 227, pl. 6, fig. 227.
Fusus geversianus (Gay) Hupé, 1854, p. 167.
Trophon geversianus Tryon, 1880, p. 144, pl. 32, figs. 337–340.
Trophon geversianus Rochebrune & Mabille, 1889, p. H 53.
Trophon geversianus Strebel, 1905*a*, p. 173, pls. 4–6.
Trophon geversianus Smith, 1905, p. 334.
Trophon geversianus Melvill & Standen, 1907, p. 106.
Trophon geversianus Strebel, 1908, p. 37, pl. 6, fig. 94*a*, *b*.
Trophon geversianus Melvill & Standen, 1914, p. 120.

TYPE LOCALITY. Strait of Magellan.

St. 56. Sparrow Cove, Port William, East Falkland Is., $1\frac{1}{2}$ cables N 50° E of Sparrow Point, 16 May 1926, $10\frac{1}{2}$–16 m.
St. 58. Port Stanley, East Falkland Is., 19 May 1926, 1–2 m.
St. 1230. 6·7 miles N 62° W from Dungeness Lt., Magellan Strait, 23 Dec. 1933, 27 m.
St. WS 847. Off Santa Cruz, Patagonia, 50° 18′ 45″ S, 67° 44′ W, 9 Dec. 1932, 56–84 m.

RANGE. Southern Chile and Argentina, Strait of Magellan, Tierra del Fuego and Falkland Is., 0–100 m. Recorded also by Melvill & Standen (1907, loc. cit.) from Scotia Bay, South Orkneys, 9–10 fathoms, but this record probably refers to the new species *echinolamellatus* described following.

DENTITION. Fig. L, 81, p. 194. The central tooth has three massive cusps, the middle one tallest, two very weak intermediates which appear as offshoots from the inner faces of the outer cusps and upturned projections at the extremities of the basal plate which may serve as cusps also. PROTOCONCH. Fig. N, 107, p. 196.

Trophon philippianus Dunker

Fusus intermedius (Gay) Hupé, 1854, p. 166, pl. 4, fig. 6 (non *Fusus intermedius* Cristofori & Jan., 1832 or Michelotti, 1846).
Trophon philippianus Dunker, 1878, p. 277, pl. 72, figs 4, 5.
Fusus intermedius Tryon, 1880, pl. 70, fig. 433 (reproduction of Gay's pl. 4, fig. 6).
Trophon intermedius Rochebrune & Mabille, 1889, 53.
Trophon geversianus philippianus Strebel, 1904*a*, p. 174, pl. 8, fig. 81*a–d*.
Trophon philippianus Melvill & Standen, 1907, p. 107.
Trophon philippianus Melvill & Standen, 1912, p. 354.

TYPE LOCALITY. Strait of Magellan.

St. WS 834. Off Strait of Magellan, 52° 57′ 45″ S, 68° 08′ 15″ W, 2 Feb. 1932, 27–38 m.

RANGE. Strait of Magellan; Falkland Is.; Burdwood Bank, South of Falkland Is., 56 fathoms (Melvill & Standen, 1912, loc. cit.).

This species lacks the lamellate axials of *geversianus*, but more material than I have at hand may show that Strebel was correct in considering *philippianus* as merely a subspecies of *geversianus*. Both forms are present in a small series of littoral shells I have from Port Stanley, Falkland Islands.

Trophon echinolamellatus n.sp., Pl. IX, figs. 44, 45

Shell large, fusiform, strongly sculptured with sharply raised spiral cords crossed by closely spaced lamellae produced into hollow recurved spines at the points of intersection. Whorls six including the last whorl of a small protoconch, much eroded in only available material. Spire tall, 0·83 of height of aperture plus canal. Sculptured with fairly prominent flat-topped spiral cords with interspaces mostly of about the same width as the cords. They number four on the first and second post-nuclear whorls, six on the penultimate and twelve on the body-whorl and base, those on the base having somewhat wider interspaces. All the post-nuclear whorls are crossed by numerous thin lamellae which are developed into sharp recurved hollow spines wherever they cross the spiral cords. There are about twenty-two axial lamellae on the penultimate and about twenty on the body-whorl, but they are irregularly disposed. In addition, the surface is scored by weak spiral striations, even on the cords, but not on the actual spines. Aperture ovate, produced below into a short obliquely recurved anterior canal. Fasciole as a high, narrow, spiral ridge imbricated with numerous hollow spines. Outer lip dilated into a polished recurved rim which is crenulated and scalloped along its outer edge by the effect of the surface sculpture. Inner lip, a moderately wide smooth callus with a well-marked, almost free edge. Colour cinnamon-buff to orange-cinnamon with traces of a spirally zoned pattern in slightly darker or more reddish brown; upper zone occupying most of the upper portion of the body-whorl, middle zone much narrower and lowest zone on the fasciole.

Height 63 mm.; diameter 35 mm. (holotype).

Height 64 mm.; diameter 39 mm. (paratype).

TYPE LOCALITY. St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.

This species stands nearest to *geversianus*, from which it differs in being more elongate and in having the lamellae produced into hollow spines. Also the surface spiral striations are not present in *geversianus*, which is white with the interior of the aperture often diffused with brown.

DENTITION. Fig. L, 83, p. 194. The central tooth has a broad, shallow, arched, basal plate, bearing three large triangular cusps, middle one tallest, and two very weak intermediate denticles which are situated in the troughs, not offshoots from the outer cusps as in *geversianus*.

Trophon scotianus n.sp., Pl. IX, figs. 48, 49

Shell rather large, thin, light buff; sculptured with elevated, coronated, thin lamellae and a surface pattern of low, rounded, spiral cords. Post-nuclear whorls five, plus a minute, smooth, papillate protoconch of $1\frac{1}{2}$ whorls, the apex oblique and inrolled. Spire 0·6 height of aperture plus canal. Axial sculpture of very prominent, thin lamellae, produced into erect coronated processes on the shoulder and extending over base to neck of canal, which is rendered prominently scaly by successive terminals of labial varices. Axials six per whorl. Spiral sculpture of rather broad, low, rounded, spiral cords with a narrow thread in each interspace. Labial varix broad, expanded and recurved, evenly arcuate right to the shallowly sinused termination of the anterior canal. Operculum irregularly ovate, with terminal nucleus.

Height 34 mm.; diameter 24 mm. (holotype).

TYPE LOCALITY. St. WS 27. Off South Georgia, 53° 55′ 00″ S, 38° 01′ 00″ W, 19 Dec. 1926, 107 m. (holotype, sole example).

DENTITION. Fig. M, 88, p. 195. The central tooth resembles that of *echinolamellatus* in having an arched base and three triangular main cusps, but the intermediates are better developed.

The species differs from *shackletoni paucilamellatus* in having fewer axial lamellae, well-developed spiral sculpture, the labial varix extending to the end of the anterior canal, and in being coloured.

Trophon shackletoni paucilamellatus n.subsp., Pl. IX, fig. 52

Shell moderately large and thin, white, with a short spire, long canal and prominent sculpture in the form of a few wide, recurved, thin, smooth lamellae which rise high above the whorls and coronate the spire. Whorls five, including a small, smooth protoconch. Axial lamellae twelve on the first post-nuclear whorl, but reduced to eight on both the penultimate and the body-whorl. The lamellae vary between seven and ten on the last two whorls in examples from other South Georgian stations. Surface of shell smooth. Spire half the height of the aperture plus canal. Canal long, slightly reflexed and recurved.

Height 31 mm.; diameter 21 mm. (holotype, St. 148).

TYPE LOCALITY. St. 148. Off Cape Saunders, South Georgia, from 54° 03′ S, 36° 39′ W to 54° 05′ S, 36° 36′ 30″ W, 9 Jan. 1927, 132–148 m.

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason Lt., 15 Mar. 1926, 100 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, from 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.
St. 144. Off Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.
St. 159. Off South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.
St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m.
St. WS 33. Off South Georgia, 54° 59′ S, 35° 24′ W, 21 Dec. 1926, 130 m.

The species *shackletoni* Hedley (1911) is found from seven to twenty fathoms off Cape Royds, in the Ross Sea on the opposite side of the Antarctic Continent.

From *shackletoni* the South Georgian subspecies differs in having fewer and more prominent axial lamellae. In Cape Royds and South Georgian shells of adult size the lamellae number from twelve to fourteen in the former and from seven to ten in the latter. Hedley's series consisted of ten examples and mine of five adults and six juveniles, so the differences noted appear constant enough to warrant separating the South Georgian shells as a new regional subspecies.

DENTITION. Fig. L, 82, p. 194 (St. 144). The central tooth is very broad and shallow, slightly arched and bears three long slender main cusps and two intermediates which lie close to the outer cusps.

Trophon brevispira von Martens

Trophon brevispira Martens, 1885, p. 91.
Trophon brevispira Martens & Pfeffer, 1886, p. 68, pl. 1, figs. 1*a*, *b*.
Trophon brevispira Strebel, 1908, p. 42, pl. 4, fig. 48*a–c*.
Trophon brevispira L. David, 1934, 2–3, p. 128.

TYPE LOCALITY. South Georgia.

St. WS 25. Undine Harbour (north), South Georgia, 17 Dec. 1926, 18–27 m.
St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m.

Only worn empty shells from both stations and evidently washed down from shallow water.

Trophon distantelamellatus Strebel

Trophon distantelamellatus Strebel, 1908, p. 43.

TYPE LOCALITY. South Georgia, 54° 23′ S, 36° 26′ W, 64–74 m.

This species bears close resemblance to young, non-eroded examples of *albolabratus*, but differs constantly in its narrower proportions and regularly crenulated axials.

St. MS 10. East Cumberland Bay, ¼ mile south-east of Hope Point to ¼ mile south of Government Flagstaff, South Georgia, 14 Feb. 1925, 26–18 m.
St. MS 67. East Cumberland Bay, 3 cables north-east of Hobart Rock to ½ cable west of Hope Point, South Georgia, 28 Feb. 1925, 38 m.
St. MS 71. East Cumberland Bay, 9¼ cables E × S to 1·2 m. E × S of Sappho Point, South Georgia, 9 Mar. 1926, 110–60 m.

DENTITION. Fig. M, 87, p. 195.

Height 40·0 mm.; diameter 18·0 mm. (holotype, *albolabratus*).
Height 24·5 mm.; diameter 16·0 mm. (holotype, *cinguliferus*).
Height 15·1 mm.; diameter 7·9 mm. (holotype, *distantelamellatus*).
Height 15·0 mm.; diameter 7·8 mm. (St. MS 67, *distantelamellatus*).
Height 19·0 mm.; diameter 9·2 mm. (St. MS 10, *distantelamellatus*).

Trophon ohlini Strebel

Trophon ohlini Strebel, 1905*a*, p. 203, pl. 3, fig. 9*a–e*.

TYPE LOCALITY. Puerto Harris, 15 fathoms, Patagonia.

St. WS 80. Between Falkland Is. and Patagonia, 50° 58′ S, 63° 39′ W to 50° 55′ 30″ S, 63° 36′ W, 3 Feb. 1927, 152–156 m.
St. WS 216. North of Falkland Is. and east of Cape Blanco, Patagonia, 47° 37′ S, 60° 50′ W, 1 June 1928, 219–133 m.
St. WS 225. Between Falkland Is. and Patagonia, 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m.
St. WS 243. Between Falkland Is. and Point Santa Cruz, Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.

DENTITION. Fig. L, 84, p. 194. The basal plate of the central tooth is broad and shallow, slightly arched, and bears three tall narrowly triangular main cusps of equal size and two well-developed intermediates, two-thirds the height of the main cusps.

The protoconch is paucispiral, asymmetrical, with almost straight-sided whorls, the top flattened, tilted, and slightly inrolled. The present material has the spiral sculpture slightly stronger than shown in Strebel's figure.

Trophon minutus (Strebel ms.) Melvill & Standen

Trophon minutus (Strebel ms.) Melvill & Standen, 1907, p. 107, pl. 1, figs. 7, 7*a*.
Trophon minutus Strebel, 1908, p. 44, pl. 4, fig. 47*a*, *b*.
Trophon minutus Melvill & Standen, 1912, p. 354.

TYPE LOCALITIES. Scotia Bay, South Orkneys, 9–15 fathoms (Melvill & Standen); South Georgia, 24–52 m. (Strebel).

St. 190. Bismark Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 93–130 m. (one example).

Trophon poirieria n.sp., Pl. IX, fig. 51

Shell small, thin, white, angulate-fusiform, tall spired, sculptured with distant upwardly produced hollow spines. Whorls 6, including the usual asymmetrical paucispiral smooth protoconch of 1½ whorls. Spire taller than height of aperture plus canal. Whorls angled just above the middle and sculptured with upwardly inclined and recurved hollow peripheral spines, seven on the penultimate and 10 on the body-whorl. Surface smooth except for axial growth lines connected with the peripheral spines. Aperture broadly ovate but produced below into a relatively long, narrow, oblique and recurved anterior canal.

Height 15·5 mm.; diameter 8·75 mm. (holotype, St. 190).

TYPE LOCALITY. St. 190. Bismark Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Aug. 1927, 93–130 m.

St. 170. Off Cape Bowles, Clarence I., South Shetlands, 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.

The species is so named on account of its resemblance to the New Zealand genus *Poirieria*. It is apparently nearest allied to *Trophon coulmanensis* Smith, 1907, but lacks both the longitudinal development of the axial lamellae and the surface striations of that species.

Trophon declinans Watson

Trophon declinans Watson, 1882, p. 388.
Trophon declinans Watson, 1886, p. 168, pl. 10, fig. 10.

TYPE LOCALITY. Off Marion I., 46° 48′ S, 37° 49′ 30″ E, 69 fathoms.

St. 1563. Off Marion I., 46° 48·4′ S, 37° 49·2′ E, 7 Apr. 1935, 113–99 m.
St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229–236 m.

Tomlin (1948, p. 228) recently recorded *declinans* from 69 m. off Macquarie Island, but this material now before me is of an angulate species with the addition of spiral sculpture. It closely resembles *pelseneeri* Smith, 1915.

Trophon cuspidarioides n.sp., Pl. IX, fig. 50

Shell small, fusiform, with a rather short spire but a disproportionately long, flexed and recurved anterior canal. Whorls about 5½, including the protoconch, which is damaged in both examples, but evidently paucispiral. Spire 0·4 time height of aperture plus canal, slightly shouldered at two-thirds whorl height. Sculpture defaced on spire whorls but on the body-whorl there are five ill-defined, blunt spiral cords, first at the shoulder angle, second between the shoulder and the lower suture, third level with the top of the aperture, fourth and fifth on the base, the fifth almost obsolete. Axials irregular, mostly weak and fold-like, about twenty-five on the body-whorl. Actual aperture ovate but produced below into a very long flexed and recurved anterior canal, very little tapered and with a blunt termina-

tion. From the back, the canal bears a striking resemblance to the rostrum of the bivalve *Cuspidaria*. Colour dull white. Operculum normal, ovate-pyriform with a terminal nucleus.

Height 13 mm.; diameter 5·7 mm. (holotype, St. 42).

TYPE LOCALITY. St. 42. Off mouth of Cumberland Bay, South Georgia, 1 Apr. 1926, 120–204 m.

St. 144. Off mouth of Stromness Harbour, South Georgia, 5 Jan. 1927, 155–178 m.

This species belongs to a southern group comprising *Trophon scolopax* Watson from between Kerguelen and Heard Islands, 150 fathoms, *Trophon septus* Watson, Royal Sound, 28 fathoms, Kerguelen Island and *Trophon acanthodes* Watson from West Patagonia in 175–245 fathoms (all figured by Watson, 1886, pl. 10).

The dentition, operculum and protoconch, so far as can be judged by the available material, shows no marked departure from those of typical *Trophon*. The abnormally long anterior canal is scarcely of sufficient taxonomic importance to warrant even subgeneric separation of this group of species.

DENTITION. Fig. M, 89, p. 195 (St. 42).

Subgenus Stramonitrophon n.subg.

Type: *Trophon laciniatus* Martyn

This new subgenus is proposed solely on account of the dentition, which is quite unlike that of other Trophons but bears a remarkable resemblance to the radula of the Thaisid genus *Stramonita* (see Troschel, 1869, pl. 12, figs. 3–9). The central tooth has a broad, shallow, rectangular base with upturned denticulate ends and three very large and tall main cusps. The middle one is slender and tallest and the side ones broad, rendered bifid by a semi-detached cusp on the inner slope and bearing four denticles on the outer slope.

The protoconch is paucispiral as in typical *Trophon*, the operculum ovate with a terminal nucleus, and the shell is fusiform with prominent lamellate axials.

Apart from the anomalous dentition, there is nothing to distinguish *laciniatus* from a normal *Trophon*.

Trophon (Stramonitrophon) laciniatus (Martyn)

Buccinum laciniatum Martyn, 1789, pl. 42.
Fusus laciniatus (Gay) Hupé, 1854, p. 168.
Trophon laciniatus Rochebrune & Mabille, 1889, p. 53.
Trophon laciniatus Strebel, 1905*a*, pl. 3, figs. 1–8.
Trophon laciniatus Strebel, 1908, p. 37.

TYPE LOCALITY. Strait of Magellan.

St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is. 25 Mar. 1927, 79 m.
St. WS 788. Between Falkland Is. and Patagonia, 45° 07′ S, 65° W to 45° 07′ S, 64° 54′ W, 13 Dec. 1931, 82–88 m.

RANGE. Strebel (1904, loc. cit) records this species from many Magellan localities; Falkland Is., 25 m.; Burdwood Bank, 137–150 m. and South Georgia, 75 m.

The South Georgia record, however, is probably based upon *shackletoni paucilamellatus* n.subsp. I am not certain if the 'Discovery' material is correctly placed in *laciniatus*, but certainly the St. WS 85 shell closely resembles Strebel's (1904) fig. 1, pl. 3, and the St. WS 788 shell his fig. 7, pl. 3.

DENTITION. Fig. L, 86, p. 194 (St. WS 788). The radula of a St. WS 85 specimen is identical.

Subgenus **Fuegotrophon** n.subg.

Type: *Fusus crispus* Gould, 1849

This new subgenus is provided for a small group of Magellan Trophons of fusiform shape with turreted spire and long canal, and sculptured with spiral cords crossed by bluntly rounded axials and a dense surface covering of low crisp lamellate ridges. Its distinctive features are a paucispiral, asymmetrical, rather bulbous, smooth protoconch and a dentition that departs somewhat from the stereotyped monotony of most Trophonoid radulae. These differences are exhibited in the central tooth, which has the massive central cusp reinforced by a buttress which extends below the lower margin of the basal plate. The basal plate is broad, shallow and rectangular, but with three basal projections caused by a downward extension of the outer basal extremities, plus the base of the central buttress. The upper and outer extremities of this plate are upwardly produced to form two extra cusps, giving a formula of seven cusps instead of the usual five. The three primary cusps are well developed with the central one largest; the intermediates are very little less in size than the outer primary cusps and of approximately equal size to the extra cusps on the outer extremities of the basal plate. The transverse ridge representing the upper edge of the central tooth bears groups of several parallel vertical grooves, or incipient denticles, at each outer extremity.

The operculum is ovate-quadrate with a blunt terminal nucleus situated at the lower right-hand corner.

Trophon (Fuegotrophon) pallidus (Broderip)

Murex pallidus Broderip, 1832, p. 194.
Fusus crispus Gould, 1849, p. 141 (non *Fusus crispus* Borson, 1821 (1822?)).
Fusus fimbriatus (Gay) Hupé, 1854, p. 165, pl. 4, fig. 7 (non *Fusus fimbriatus* Borson, 1821 (1822?)).
Fusus fasciculatus Hombron & Jacquinot, 1854, p. 110, pl. 25, figs. 15, 16.
Trophon crispus Tryon, 1880, II, p. 143, pl. 31, figs. 328, 329, pl. 70, fig. 437.
Trophon crispus Strebel, 1905*a*, p. 204, pl. 3, fig. 10 *a–g*.
Trophon crispus Melvill & Standen, 1907, p. 106.
Trophon crispus burdwoodianum Strebel, 1908, p. 38, pl. 1, fig. 15*a–c*.

Type localities. Falkland Is. (*pallidus*); Strait of Magellan (*crispus*, *fimbriatus* and *fasciculatus*); Burdwood Bank, 137–150 m. (*burdwoodianum*).

St. 51. Off Eddystone Rock, East Falkland I., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., $1\frac{1}{2}$ cables N 50° E of Sparrow Point, 16 May 1926, $10\frac{1}{2}$–16 m.
St. 57. Port William, East Falkland Is., $5\frac{1}{2}$ cables S 20° W of Sparrow Point, 16 May 1926, 15 m.
St. 388. Between Cape Horn and Staten I., 56° $19\frac{1}{2}'$ S, 67° $09\frac{3}{4}'$ W, 16 Apr. 1930, 121 m.
St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 25 Mar. 1927, 79 m.
St. WS 88. North of Staten I. from 54° S, 65° W to 54° S, 64° 55′ W, 6 Apr. 1927, 118–118 m.
St. WS 750. Off entrance to Strait of Magellan, 19 Sept. 1931, 95 m.
St. WS 824. Off Falkland Is., 52° 29′ S, 58° 27′ W, 19 Jan. 1932, 146–137 m.

I have selected *pallidus* as the earliest name for the well-known but preoccupied *crispus* since the type locality Falkland Islands and Sowerby's figure seem to indicate this species, but if my interpretation should prove to be incorrect, then *fasciculatus* Hombron & Jacquinot must be used. Cossmann's substitute name *Trophon gouldi* (1903, p. 54) was bestowed upon a New Zealand Pliocene fossil, wrongly ascribed to *crispus*.

The small sculptural differences upon which Strebel based his *burdwoodianum* are covered by the normal range of variation within the species. The *burdwoodianum* type of sculpture (widely spaced spirals) is mostly found in the deep-water stations, but the fact that both forms occur at the shallow-water ($10\frac{1}{2}$–16 m) St. 56 precludes the interpretation of *burdwoodianum* as a benthic subspecies.

Dall (1902*b*, p. 535) described an apparently closely related species, *T. pelecetus*, which is based upon Gould's *Fusus crispus* var. (1852, p. 229, pl. 16, fig. 279*b*).

DENTITION. Fig. L, 85, p. 194 (St. 56). PROTOCONCH. Fig. N, 111, p. 196.

Genus Xymenopsis n.g.

Type: *Fusus liratus* Gould

This genus is provided for a large group of Magellan species which differ from typical *Trophon* in having a tall, narrowly conic, polygyrate protoconch instead of a paucispiral asymmetrical one, and sculpture in the form of rounded axial varices crossed by spiral cords, but never lamellate processes. The style of protoconch is similar to that of the New Zealand genus *Zeatrophon* and the sculpture to that of *Xymene*, another New Zealand genus.

The central tooth of the radula is distinctive in that the base is a simple, broad, shallow, almost straight bar with rounded ends and the cusps, consisting of three tall, slender primaries and two intermediates appear as serrations of a single outgrowth from the basal plate.

There is a large number of nominal species in this group, but doubtless many of them ultimately will prove to be synonyms. The following names refer to members of the genus *Xymenopsis: acuminatus* Strebel, 1904; *albidus* Philippi, 1846; *albus* and *brucei* Strebel, 1904; *cancellarioides* Reeve, 1847 (=*liratus* Gould); *cancellinus* Philippi, 1845; *candidatus* Rochebrune & Mabille, 1889; *corrugatus* Reeve 1848; *couthouyi* Strebel, 1904; *decolor* Philippi, 1845; *dispar* Rochebrune & Mabille, 1889; *elegans* and *elongatus* Strebel, 1904; *falklandicus* Strebel, 1908; *fenestratus* and *hoylei* Strebel, 1904; *lebruni* Rochebrune & Mabille, 1889; *liratus* Gould, 1849; *loebbeckei* Rochebrune & Mabille, 1889; *obesus*, *ornatus*, *paessleri* and *paessleri turrita* Strebel, 1904; *plumbeus* Gould, 1852; *pseudoelongatus* and *ringei* Strebel, 1904; *roseus* Hombron & Jacquinot, 1853 (=*plumbeus*?); *standeni* Strebel, 1904; *textiliosus* Hombron & Jacquinot, 1854 (=*liratus* Gould); and *violaceus* Rochebrune & Mabille, 1889.

An evaluation of these names is not possible without recourse to the type material which is in European museums.

Xymenopsis liratus (Gould)

Buccinum cancellarioides Reeve, ?1847 (Feb.) (non *Buccinum cancellaroides* Bast. in Grateloup '1840–1846', stated by Sherborn to be 1847).
Fusus liratus (Couthouy ms.) Gould, 1849, p. 141 (non *Fusus lyratus* Deshayes, 1843).
Fusus textiliosus Hombron & Jacquinot, 1854, pl. 25, figs. 9, 10 (non Deshayes, 1835).
Trophon liratus Strebel, 1905*a*, p. 238, pl. 8, fig. 74*a–c*.
Trophon liratus Melvill & Standen, 1907, p. 107.
Trophon liratus Strebel, 1908, p. 37.
Trophon liratus Melvill & Standen, 1914, p. 120.

TYPE LOCALITY. Patagonia (*liratus*).

St. 52. Port William, East Falkland Is., 7·4 cables N 17° E of Navy Point, 5 May 1926, 17 m.
St. 1230. 6·7 miles N 62° W from Dungeness Lt., Magellan Strait, 23 Dec. 1933, 27 m.
St. WS 784. North of Falkland Is., 49° 47′ 45″ S, 61° 05′ W, 5 Dec. 1931, 170 m.

It seems probable that Reeve's *Buccinum cancellarioides* from unknown locality is identical with Gould's *Fusus liratus*, but I hesitate to upset a well-known name, expecially since the actual date of the

conflicting *Buccinum cancellaroides* Bast. is in doubt. Deshayes's *Fusus lyratus* does not affect Gould's *F. liratus*, since the derivations are different.

I have placed in *liratus* all the shells with the axials cut by linear spiral grooves. These number about seven on the penultimate. In the numerous allied species the spiral ribs have wider interspaces which are either plain or with an intermediate spiral. PROTOCONCH. Fig. N, 110, p. 196.

The shallow-water shells from the Falkland Islands usually seen in collections as '*liratus*' are *brucei* Strebel, 1904. Compared with my interpretation of *liratus* these shells have wider spiral interspaces with intermediates on the last whorl and the aperture is rather square and more capacious.

Xymenopsis albidus (Philippi)

Fusus albidus Philippi, 1846, p. 119.
Trophon albidus Strebel, 1904, p. 222, pl. 7, fig. 64*a–d*.

TYPE LOCALITY ?Magellanic

St. WS 71. 6 miles N 60° E of Cape Pembroke Lt., East Falkland Is., 23 Feb. 1927, 82 m.
St. WS 88. Off Staten I., Tierra del Fuego, 54° S, 65° W to 54° S, 64° 55′ W, 6 Apr. 1927, 118–118 m.
St. WS 97. Between Falkland Is. and Patagonia, 49° S, 62° W to 49° 01′ S, 61° 56′ W, 18 Apr. 1927, 146–145 m.
St. WS 222. South-east of Puerto Deseado, Patagonia, 48° 23′ S, 65° W, 8 June 1928, 100 m.
St. WS 243. Off Santa Cruz, Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.
St. WS 750. North-east of Falkland Is., 51° 50′ S, 57° 15′ 13″ W, 18/19 Jan. 1932, 135–144 m.
St. WS 805. Between Falkland Is. and Patagonia, from 50° 11′ S, 63° 27′ W to 50° 09·5′ S, 63° 31′ W, 6 Jan. 1932, 150–148 m.
St. WS 808. Off Santa Cruz, Patagonia, 49° 40′ 15″ S, 65° 42′ W, 8 Jan. 1932, 109–107 m.
St. WS 829. Between Falkland Is. and Patagonia, 50° 51′ S, 63° 13′ 30″ W, 31 Jan. 1932, 155 m.
St. WS 834. Off Bahia Grande, Patagonia, 52° 57′ 45″ S, 68° 08′ 15″ W, 2 Feb. 1932, 27–38 m.
St. WS 838. Between Falkland Is. and Patagonia, 53° 11′ 45″ S, 65° W, 5 Feb. 1932, 148 m.
St. WS 861. Off Puerto Deseado, Patagonia, 47° 40′ S, 64° 12′ W, 27 Mar. 1932, 117–124 m.
St. WS 863. Between Falkland Is. and Patagonia, 49° 05′ S, 64° 09′ W, 28 Mar. 1932, 121–117 m.
St. WS 865. Between Falkland Is. and Patagonia, 50° 03′ S, 64° 14′ W, 29 Mar. 1932, 126–128 m.
St. WS 867. Between Falkland Is. and Patagonia, 51° 10′ S, 64° 15′ W, 29 Mar. 1932, 137–144 m.
St. WS 869. Between Falkland Is. and Patagonia, 52° 15′ 30″ S, 64° 13′ 45″ W, 31 Mar. 1932, 187–0 m.

This shell, which is widely distributed in the deeper waters of the Falklands-Magellan area, is referred to *albidus* on the basis of Strebel's interpretation (1904).

DENTITION. Fig. M, 90, p. 195 (St. 834).

Xymenopsis falklandicus Strebel, Pl. IX, figs. 46, 47

Trophon falklandicus Strebel, 1908, p. 39, pl. 1, fig. 8*a–c*.
Trophon falklandicus Melvill & Standen, 1912, p. 354.

TYPE LOCALITY. Falkland Is., 7–40 m.

St. 55. Entrance to Port Stanley, East Falkland Is., 2 cables S 24° E of Navy Point, 16 May 1926, 10–16 m.
St. 56. Sparrow Cove, Port William, East Falkland Is., 1½ cables N 50° E of Sparrow Point, 16 May 1926, 10½–16 m.

Melvill & Standen (1912) consider this species doubtfully distinct from *paessleri* Strebel, 1904, from Smyth Channel, Strait of Magellan, but it is much nearer to, if not identical with *hoylei* Strebel 1904.

As previously remarked, Strebel described so many closely similar Trophons of this group from the Magellan Region that it is useless to attempt their evaluation without recourse to the type specimens.

Family MARGINELLIDAE

Genus **Marginella** Lamarck, 1799

Type (monotypy): *Voluta glabella* Linn.

Marginella warrenii Marrat, Pl. X, fig. 67.

Marginella warrenii Marrat, 1876, p. 136.
Marginella warrenii Tryon, 1883, p. 56.
Marginella hahni Mabille, 1884, p. 132.
Marginella hahni Rochebrune & Mabille, 1889, p. H 51, pl. 3, fig. 3*a*, *b*.
Marginella warrenii Tomlin, 1917, p. 305.

Type localities. Between Falkland Is. and Strait of Magellan, '50° 23′ 5″ N, 64° 0′ 4″ W' (N cited in error for S latitude) (*warrenii*); between Strait of Magellan and Falkland Is. in 120 m. (*hahni*).

St. WS 88. Off Le Maire Strait, Tierra del Fuego, 54° 00′ 00″ S, 64° 57′ 30″ W, 6 Apr. 1927, 118 m.
St. WS 212. North of Falkland Is., 49° 22′ 00″ S, 60° 10′ 00″ W, 30 May 1928, 242-249 m.
St. WS 213. North of Falkland Is., 49° 22′ 00″ S, 60° 10′ 00″ W, 30 May, 1928, 249–239 m.
St. WS 216. North of Falkland Is., 47° 37′ 00″ S, 60° 50′ 00″ W, 1 June 1928, 219–133 m.
St. WS 228. North-east of Falkland Is., 50° 50′ 00″ S, 56° 58′ 00″ W, 30 June 1928, 229–236 m.
St. WS 237. North of Falkland Is., 46° 00′ 00″ S, 60° 05′ 00″ W, 7 July 1928, 150–256 m.
St. WS 244. North-west of Falkland Is., 52° 00′ 00″ S, 62° 40′ 00″ W, 18 July 1928, 253–247 m.
St. WS 245. West of Falkland Is., 52° 36′ 00″ S, 63° 40′ 00″ W, 18 July 1928, 304–290 m.
St. WS 816. West of Falkland Is., 52° 09′ 45″ S, 64° 56′ 00″ W, 14 Jan. 1932, 150 m.
St. WS 820. North-east of West Falkland Is., 52° 53′ 15″ S, 61° 51′ 30″ W, 18 Jan, 1932, 351–367 m.
St. WS 867. Between Falkland Is. and Patagonia, 51° 10′ S, 64° 15·5′ W, 30 Mar. 1932, 150–147 m.

Range. Falkland Is. to Patagonia and Tierra del Fuego, 118–367 m.

Dentition. A number of examples were dissected but no radula was located.

This is a handsome shell over 20 mm. in height, highly glazed and white with two equally broad flesh-coloured spiral bands. By an initial error the locality was given as north instead of south latitude, which credited the species to eastern Canadian waters until the error was discovered by Bavay (see Tomlin, loc. cit. p. 305).

Marginella dozei Rochebrune & Mabille, Pl. X, fig. 66

Marginella dozei Rochebrune & Mabille, 1889, p. H 52, pl. 3, fig. 4*a*, *b*.

Type locality. Between Strait of Magellan and Falkland Is. in 120 m.

St. 388. Between Cape Horn and Tierra del Fuego, 56° 19½′ S, 67° 09¾′ W, 16 Apr. 1930, 121 m.

A similar species to *warrenii* but smaller and with a different colour pattern. There are two spiral colour bands, the upper one being narrow and submargining the suture and the lower one occupying most of the base.

Large, highly glazed Marginellids are usually of tropical occurrence.

Family VOLUTIDAE

Genus **Adelomelon** Dall, 1906

Type (o.d.): *Voluta ancilla* Solander

The vexed question of the type designation of Swainson's *Cymbiola* was dealt with in detail by Marwick (1926, pp. 263, 264). This requires pointing out, for Thiele (1931, p. 350) has persisted in the old interpretation of *ancilla* Solander as type of Swainson's *Cymbiola*. The actual genotype of *Cymbiola*

Swainson, 1832 is *C. broderipia* Swainson (n.nom. for *Voluta cymbiola* Swainson. Type by tautonomy). Dall's substitute name *Adelomelon*, 1906, is therefore the correct genus for the series of Magellan volutes centred around Solander's *ancilla*.

Adelomelon ancilla (Solander)

(*ancilla*)

'Grand Buccin Magellanique', D'Avila, 1767, pl. 8, fig. S, no. 181.
Voluta ancilla, Solander, 1786, p. 137, no. 3061.
Voluta magellanica, Chemnitz, 1788, pp. 138–9 (exclusive of figures).
Voluta spectabilis, Gmelin, 1791, p. 3468. no. 142.
Voluta ancilla Lamarck, 1816, pl. 385, fig. 3.
Cymbiola ancilla Pace, 1902, p. 28, pl. 7, figs. 1–16.
Voluta ancilla Strebel, 1906, pl. 8, figs. 25 (copy of D'Avila's figure), 18, 20, 22, 23; pl. 9, figs. 37, 45, 50, 51.
Adelomelon ancilla Dall, 1906, p. 143.
Adelomelon ancilla Dall, 1907, p. 355.
Adelomelon ancilla Smith, 1942, p. 55, pl. 25, fig. 171.

(*magellanica*)

Voluta magellanica Chemnitz, 1788, pp. 138–9 (in part), figs. 1383, 1384.
Voluta magellanica Gmelin, 1791, p. 3465, no. 110.
Voluta magellanica Kiener, 1839, pl. 51.
Voluta ancilla Reeve, 1849, pl. 17, fig. 39.
Voluta bracata Rochebrune & Mabille, 1889, p. 48.
Scaphella (*Voluta*) *arnheimi* Rivers, 1891, locality 'Monterey Bay, California' false.
Voluta ancilla with vars. *typica, ponderosa, elongata, expansa* and *abbreviata* Lahille, 1895, p. 311.
Voluta magellanica Strebel, 1906, pl. 8, figs. 17, 19, 21, 24–32; pl. 9, figs. 36 and 41.
Adelomelon magellanica Dall, 1907, p. 355.
Adelomelon magellanica Smith, 1942, p. 57, pl. 11, fig. 83.

(The above is an abridged synonomy.)

Most of the 'Discovery' volutes are more or less elongated shells without nodules. Larger series than I have available will be necessary to determine if *magellanica* is really distinct from *ancilla*. Variation is considerable, so much so that it is difficult to match individual specimens with the original figures. In several instances *ancilla* and *magellanica* forms are present in one dredging station, and more often than not, examples tend to combine in varying degrees the differentiating criteria set out by Dall (1889*a* p. 312). Dall stated that '*S. magellanica* is much like the *S. ancilla* from which it is chiefly distinguished by its smaller size, more slender form and usually fewer plaits'.

Since I am unable to draw a satisfactory line between *ancilla* and *magellanica* I have for the present referred the 'Discovery' material to the prior name. That is all the examples that range between the figure of D'Avila (1767) = *ancilla* and that of Chemnitz (1788) = *magellanica*.

Type localities. Strait of Magellan (*ancilla* and *magellanica*).

St. 51. Off Eddystone Rock, East Falkland Is., 4 May 1926, 115 m.
St. 1902. Off Santa Cruz, Patagonia, 49° 48′ S, 67° 39·5′ W, 28 Nov. 1936, 50–30 m.
St. WS 71. 6 mile N 60° E of Cape Pembroke Lt., East Falkland Is., 23 Feb. 1927, 82–80 m.
St. WS 83. 14 miles S 64° W of George I., East Falkland Is., 52° 28′ S, 60° 06′ W to 52° 30′ 00″ S, 60° 09′ 30″ W, 24 Mar. 1927, 137–129 m.
St. WS 109. North of Falkland Is., 50° 19′ S, 58° 27′ W to 50° 18′ 36″ S, 58° 30′ W, 26 Apr. 1927, 145 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m. (two empty shells).
St. WS 247. North of Falkland Is., 52° 40′ S, 60° 05′ W, 19 July 1928, 172 m.
St. WS 776. Gulf of St George, Patagonia, 46° 18′ 15″ S, 65° 02′ 15″ W, 3 Nov. 1931, 50–80 m.

Range. Argentina, Patagonia, Straits of Magellan and Falkland Is., 0–172 m.

Tables A and B show the difficulty of recognizing more than one variable species with the 'Discovery' material.

Table A. Ancilla *and* magellanica *forms*

Height (mm.)	Diameter (mm.)	Ratio (aperture to total height)	Plaits	Station
212	76	1·6	3	1902
205	80	1·5	3	1902
180	78	1·4	3	WS 776
126	41	1·9	2	WS 83
120	39	1·8	2	WS 83
100	37	1·6	2	WS 109
96	34	1·7	2	WS 83
95	37	1·6	2	WS 109
82	32	1·8	2	WS 247

Table B. *Showing variation in individuals from the same station*

Height (mm.)	Diameter (mm.)	Spire ratio	Plaits	Fasciole	Protoconch	Station
141	45	1·8	2	Slight	Small	WS 71 }
123	55	1·48	3	Bulging	Large	WS 71 }
111	44	1·45	3	Bulging	Large	WS 243 }
93	35	1·85	2	Slight	Small	WS 243 }

If two forms require to be recognized, examples from St. 1902 and WS 776 conform with *ancilla* in being large with three plaits and a spire ratio ranging between 1·4 and 1·6. The remaining stations represent the smaller *magellanica* form which is more slender has two plaits and a spire ratio ranging between 1·6 and 1·9.

However, in the writer's opinion, such arbitrarily selected criteria lose status when other varying characters are considered, such as the relative size of the protoconch and the presence or otherwise of a bulging fasciole.

It has been pointed out by Dall (1919, pp. 207–34) and others that where several embryos develop in one egg capsule competition results in varying sizes in these embryos. In the New Zealand *Alcithoe arabica* it has been noted that when a capsule develops two or more embryos they are invariably small and in instances where only one persists it grows abnormally large.

It seems that in *Adelomelon ancilla* a small protoconch develops into a narrow tall-spired shell with a slight fasciole development and two columellar plaits, and conversely a large protoconch is associated with a wider, short-spired shell, a bulging fasciole and three columella plaits.

DENTITION. Pace (1902).

The radula is reduced to a row of tricuspid central teeth, as in most volutes.

Adelomelon mangeri (Preston)

Cymbiola mangeri Preston, 1901, p. 237, fig. in text.
Adelomelon mangeri Smith, 1942, p. 59, pl. 12, fig. 89.

TYPE LOCALITY. Falkland Is.

Off Jetty, Port Stanley, Falkland Is., 23 Mar. 1937, 1 m.

Height (mm.)	Diameter (mm.)	Ratio (aperture to total height)	Plaits	Station
103	56	1·3	3	(Holotype)
180	92	1·25	3	(Disc. II St.)
121	62	1·3	3	(Falkland Is.) (A.W.B.P. Coll.)

This seems to be a stable species so far known only from the Falkland Islands. It is characterized by its large, swollen body-whorl, short spire, large protoconch and lack of both nodules and colour pattern. It has apparently developed either as an inflated squat derivative of *ancilla* or more likely as a smooth patternless form of *subnodosa*.

Other species of *Adelomelon* recorded from the Magellan province are: *beckii* Broderip, 1836; *ferussacii* Donovan, 1824; *martensi* Strebel, 1906; and *tuberculata* Swainson, 1821.

Genus Miomelon Dall, 1907

Type (o.d.): *Volutilithes philippiana* Dall

Although it has several atypical features, the shell described below is probably correctly placed in *Miomelon*. The genus was proposed for a small Volute, 36·5 mm. in height, from 677 fathoms, south-west coast of Chile. The genotype is dark olivaceous-ash colour, with a tall spire equal to the height of the aperture, and the surface is sculptured with weak axial narrow folds and numerous half-obsolete spiral striations. The columellar plaits number three, the anterior sinus is broad and very shallow, there is no columellar callus plate and the fasciole is not margined. A very characteristic feature is the form of the suture, which is deeply and narrowly channelled, but adpressed below by a distinct concavity.

The new species described below has a short spire and the sculpture is almost obsolete, but the form of the suture, the plaits, absence of a columellar plate, weak, broad anterior notch and ill-defined fasciole are the significant characters in accord with *Miomelon*.

The Chilean Tertiary Volutes, *d'orbignyana*, *domeykoana* and *gracilis* Philippi, *indurata* Conrad and *triplicata* Sowerby, were quoted as congeneric with *philippiana* by Dall (1907). The new species is not unlike the New Zealand *Palomelon* Finlay, 1926, but that genus lacks the channelled suture, has a more clearly defined fasciole and no spiral sculpture.

Miomelon scoresbyana n.sp., Pl. IX, fig. 43

Shell small, solid, white, broadly fusiform with low conical spire 0·35 time height of aperture. Whorls about six (protoconch eroded). Suture deeply and narrowly channelled and adpressed below by a wide shallow concavity. Anterior notch broad and very shallow, fasciole defined only by the trend of the growth lines, not marked off in any way. Posterior notch deep, narrow and constricted, forming a weak sutural sinus. Plaits three, strong and of equal development, or four if the anterior thickened edge of the columella is included. Sculpture consisting of very numerous but very weak axial growth lines and equally numerous subobsolete spiral threads. The parietal glaze is cream coloured and extends half-way across the front of the body-whorl.

Height 48·4 mm.; diameter 25·5 mm.

TYPE LOCALITY. St. WS 816. Between Falkland Is. and Strait of Magellan, 52° 09′ 45″ S, 64° 56′ W, 14 Jan. 1932, 150 m.

The animal has the foot rather pointed posteriorly, is comparatively smooth, and the tentacles are long and tapered (10 mm.) with the eyes at the outer side of the bases. Dall found the eyes to be absent in the genotype, but the much greater depth at which it was taken (677 fathoms) would account for this absence.

The radula has not been removed, since it seems desirable to keep the only available animal intact. Experience has shown that the Volutid radula is almost invariably of the same type, that is, a single row of tricuspid central teeth.

The species is named in recognition of the many novelties obtained in the trawling surveys in Magellan waters from the R.R.S. *William Scoresby*.

Genus **Harpovoluta** Thiele, 1912

Type (monotypy): *Harpovoluta vanhoffeni* Thiele

Harpovoluta charcoti (Lamy)

Buccinum charcoti Lamy, 1910*b*, p. 318.
Buccinum charcoti Lamy, 1911*a*, p. 4, pl. 1, figs. 1, 2.
Harpovoluta charcoti Thiele, 1912, p. 271.
Volutharpa charcoti Smith, 1915, p. 72.
Volutharpa charcoti Eales, 1923, p. 33 (anatomy and radula).

TYPE LOCALITY. Off King George Sound, South Shetlands, 420 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, in 342 m.

RANGE. South Shetlands, 420 m.; Clarence I., 342 m.; off Oates Land, 180–200 fathoms (Smith, 1915).

DENTITION. Eales (1923) gives a very full account of the anatomy, a figure of the dentition, and refers this shellfish to the Volutidae. For some unaccountable reason, however, Thiele's *Harpovoluta* was suppressed by Smith and Eales in favour of *Volutharpa*, which is, however, definitely Buccinoid. The radula in *charcoti* is typically Volutid, consisting of a tricuspid central tooth only.

Tomlin (1948, p. 229) recorded *Harpovoluta vanhoffeni* Thiele from 69 m. off Macquarie Island.

Genus **Provocator** Watson, 1882

Type (monotypy): *Provocator pulcher* Watson

Provocator cf. **pulcher** Watson

Provocator pulcher Watson, 1882, p. 330.
Provocator pulcher Watson, 1886, p. 260, pl. 13, fig. 5.

TYPE LOCALITY. Off Cumberland Bay, Kerguelen I. 105 fathoms. Between Kerguelen I. and Heard I., 150 fathoms (Challenger).

St. WS 245. Between Falkland Is. and Patagonia, 52° 36′ S, 63° 40′ W, 18 July 1928, 304–290 m.

The solitary 'Discovery' example is a juvenile of only three post-nuclear whorls, but it tallies well with Watson's detailed description of the adult holotype. The holotype is about 90 mm. in height (3·6 in.)—the St. WS 245 example 32 × 14 mm. The present example has an excellently preserved 'Caricellid' protoconch, the apical spike being prominent and curved to one side. The deep sutural sinus, concave, smooth, enamelled subsutural band and delicately axially and spirally sculptured surface, are particularly noticeable. In the holotype the outer lip bulges prominently outwards below the middle, but the 'Discovery' example lacks this feature, no doubt because this shell is juvenile.

The animal is very contracted in the one available juvenile, but the elongate-oval foot is shown to be strongly rugose on the posterior upper surface, and the head is broad with two rather flattened short stout tentacles. There are no eyes.

DENTITION. The radula is typically Volutid, consisting of a long series of the usual tricuspid central tooth.

The finding of this genus in the Magellan Province represents a considerable westward extension of the range of the genus, which previously was recorded only from the vicinity of Kerguelen and Heard Islands.

Genus Paradmete Strebel, 1908

Type (here designated): *Paradmete typica* Strebel

This Antarctic genus was ascribed by its author to the Cancellariidae, but Thiele (1929, p. 351) figured the radula which is very similar to that of the Boreal *Volutomitra*, an atypical member of the Volutidae. Both *Paradmete* and *Volutomitra* have a spur-shaped central tooth and a pair of irregularly shaped lateral plates, without cusps.

There are sufficient differences in detail, however, between the radulae of each to warrant retaining both genera at present, but that they have had a common ancestry is almost certain.

Thiele (1929, loc. cit.) evaluated these shells as follows:

Subfamily Volutomitrinae (of the Volutidae).
Genus *Volutomitra* H. & A. Adams, 1853.
Section *Volutomitra* (S.S.)
Section *Microvoluta* Angas, 1877 (=*Paradmete* Strebel, 1908).

Peile (1922, p. 18, text-fig. 8) figured and described the radula of the New South Wales *australis* Angas, the genotype of *Microvoluta*. This species has a central tooth more like that of *Paradmete* than that of *Volutomitra*, but differs from both in the absence of laterals. There is no marked similarity between the relatively large and thin *Paradmete*, which has narrow, not very conspicuous columellar plaits and the quite small, solid *Microvoluta*, with strong, very oblique plaits and a disproportionately large, smooth, paucispiral protoconch. They should be kept separate until more is known concerning their anatomy.

Unfortunately, the several living examples from the 'Discovery' material had been plunged into strong alcohol and were too hardened and contracted to be worth dissecting.

Paradmete fragillima (Watson)

Volutomitra fragillima Watson, 1882, p. 334.
Volutomitra fragillima Watson, 1886, p. 263, pl. 14, fig. 7.
Paradmete typica Strebel, 1908, p. 22, pl. 3, fig. 35*a–f*.
Paradmete typica Melvill & Standen, 1912, p. 357.
Volutomitra fragillima Smith, 1915, p. 74.

Type localities. Royal Sound, 28 fathoms, Kerguelen I. (*fragillima*); South Georgia, 75 m. (*typica*).

St. 27. West Cumberland Bay, South Georgia, 3·3 m. S 44° E of Jason Lt., 15 Mar. 1926, 110 m.
St. 140. Stromness Harbour to Larsen Point, South Georgia, 54° 02′ S, 36° 38′ W to 54° 11′ 30″ S, 36° 29′ W, 23 Dec. 1926, 122–136 m.
St. 156. North of South Georgia, 53° 51′ S, 36° 21′ 30″ W, 20 Jan. 1927, 200–236 m.
St. 159. North of South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.
St. 190. Bismarck Strait, Palmer Archipelago, 64° 56′ S, 65° 35′ W, 24 Mar. 1927, 315 m.

Range. Kerguelen I., 28 fathoms (Watson); off Oates Land, 69° 43′ S, 163° 24′ E, 180–200 fathoms (Smith); South Georgia, 24–310 m. (Strebel and 'Discovery'); Palmer Archipelago, 315 m. ('Discovery') and Burdwood Bank, 56 fathoms (Melvill & Standen).

I have seen only South Georgian and Palmer Archipelago material, but Smith (1915) remarked that 'The Kerguelen shell figured by Watson has a much shorter spire than other specimens from the same locality which agree perfectly with Strebel's figure of *Paradmete typica*'.

Paradmete longicauda Strebel

Paradmete longicauda Strebel, 1908, p. 24.

Type locality. South Georgia, 54° 22′ S, 36° 27′ W, 95 m.

St. 27. West Cumberland Bay, South Georgia, 3·3 miles S 44° E of Jason Lt., 15 Mar. 1926, 110 m.

This species has only two columellar plaits, whereas *fragillima* has four. There is a third member of the genus, *Paradmete curta* Strebel (1908), from off Shag Rock Bank, north of South Georgia, in 160 m.

Melvill & Standen's *Mitra* (*Volutomitra*) *porcellana* (1912) from Scotia Bay, 9–10 fathoms, South Orkneys, is not congeneric and will probably prove to be a *Marginella*.

Paradmete percarinata n.sp., Pl. IX, fig. 57

Shell broadly ovate, with a prominent peripheral carina, a flat shoulder, and a short, tabulated spire. Whorls four, exclusive of the protoconch, which is missing. Spire-whorls with the carina slightly below the middle, the flat-sloping shoulder with the upper half smooth and the lower half with five to six linear-spaced, weak, spiral threads; the area below the carina straight, slightly undercut, and sculptured with four to six linear-spaced spirals. Body-whorl and base with about forty-five spirals between the carina and the fasciole, which is devoid of spirals. Axial sculpture confined to weak, irregular growth lines. Aperture long and narrow, produced below into a short anterior canal. Outer lip thin, inner lip with three columella plaits, upper two well developed, lowest one weak.

Height 16·5 mm. (estimated, 17 mm.); diameter 10·5 mm.

TYPE LOCALITY. St. 1957. Off south side of Clarence I., 7 miles east of Cape Bowles, South Shetland Is., 3 Feb. 1937, 785–810 m. (one empty shell).

In form this species closely resembles *Cancellaria* (*Admete*) *carinata* Watson (1886, pl. 18, fig. 9) from Kerguelen Island in 28 fathoms, but Watson's species has 'two indistinct folds' on the pillar, which suggests that it is correctly placed in the Cancellariidae. The well-developed plaits in *percarinata*, on the other hand, are of similar style and strength to those of both *fragillima* and *longicauda*.

Paradmete crymochara (Rochebrune & Mabille)

Mitra crymochara Rochebrune & Mabille, 1885, p. 102.
Mitra crymochara Rochebrune & Mabille, 1889, p. H 49, pl. 3, fig. 1.

TYPE LOCALITY. South-east of Tierra del Fuego, 220 m.

St. 388. Between Cape Horn and Staten I., 56° 19½′ S, 67° 09¾′ W, 16 Apr. 1930, 121 m. (two empty shells).

Height 12·0 mm.; diameter 6·0 mm. (holotype).

Height 20·5 mm.; diameter 7·25 mm. (St. 388).

Although the 'Discovery' specimens are much larger than the holotype of *crymochara* they seem to be the adult of that species. The shell is narrowly ovate-fusiform, has a smooth papillate protoconch of 2½ whorls, the tip asymmetrical, four well-developed plaits on the pillar, a weakly defined shoulder bearing three fine spiral threads and dense subobsolete spiral lirations over the remainder of the whorls. The whole shell is covered with a thin, pale buff epidermis.

Family CANCELLARIIDAE

Genus Admete Kroyer, 1842

Type (monotypy): *Admete crispa* Moeller, 1842

Admete magellanica Strebel

Admete magellanica Strebel, 1905*b*, p. 594, pl. 22, fig. 29*a–d*.
Admete magellanica Melvill & Standen, 1907, p. 111.

TYPE LOCALITY. Smyth Channel, Strait of Magellan.

St. WS 84. 7½ miles S 9° W of Sea Lion I., East Falkland Is., 52° 33′ S, 59° 08′ W to 52° 34′ 30″ S, 59° 11′ W, 24 Mar. 1927, 75–74 m.

St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229–236 m.

St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1928, 144–141 m.

St. WS 244. West of Falkland Is., 52° S, 62° 40′ W, 18 July 1928, 253–247 m.
St. WS 250. North of Falkland Is., 51° 45′ S, 57° W, 20 July 1928, 251–313 m.
St. WS 797. North-west of Falkland Is. to Patagonia, 51° 06′ S, 64° 10′ 30″ W to 47° 47′ 43″ S, 64° 07′ 30″ W 19 Dec. 1931, 117 m.
St. WS 801. North-west of Falkland Is. to Patagonia, 48° 26′ 15″ S, 61° 28′ W, 22 Dec. 1931, 165–165 m.

RANGE. Many localities around Strait of Magellan, 10–20 fathoms (Strebel); Port Stanley, Falkland Is., shore (Melvill & Standen).

The carinate form figured by Strebel (1905*b*, fig. 29*b*) was not encountered. The example from St. WS 250 has finer and more numerous spiral ribs, fourteen on the penultimate, but eight to eleven spirals is characteristic of the other 'Discovery' material. Strebel's figures show a variation of between five and nine penultimate spirals.

This species is not dissimilar from the boreal genotype, and like it has neither radula nor operculum.

Admete cf. antarctica Strebel

Admete antarctica Strebel, 1908, p. 21, pl. 4, fig. 44*a–c*.

TYPE LOCALITY. South-west of Snow Hill I., 64° 36′ S, 57° 42′ W, 125 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m. (one living example).
St. 175. Bransfield Strait, South Shetland Is., 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.

The St. 170 example is only 7 mm. in height compared with 11·6 mm. for Strebel's type, but it is a half-whorl smaller and evidently not fully grown. The weak shoulder carination is slightly stronger than shown in Strebel's figure, but the number of spiral ribs is approximately the same.

Admete consobrina n.sp. Pl. X, fig. 63

Shell small, thin, translucent with a pale buff epidermis; ovate with a carinated shoulder. Spire less than one-third height of aperture. Whorls about $4\frac{1}{2}$, protoconch small, eroded in only specimen. Sculpture consisting of distinct flat-topped spiral cords with interspaces varying from linear to half the width of the cords. The peripheral cord is strongest, and there are five cords above it and four below it on the spire-whorls and about thirty on the body-whorl from below the carina. The columella is a smooth vertical callus slightly flexed at the anterior canal and bears two very weak plications. Aperture narrowly ovate-pyriform. Outer lip thin and delicately corrugated by the external sculpture.

Height 9·75 mm.; diameter 6·6 mm.

TYPE LOCALITY. St. 159. North of South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.

It is very similar to *Cancellaria* (*Admete*) *carinata* Watson from Kerguelen Island, 28 fathoms, but that species has a smooth shoulder and only two spiral cords between the carina and the lower suture.

Family TURRIDAE

Genus Aforia Dall, 1889

Type (o.d.) *Pleurotoma circinata* Dall = *Irenosyrinx* Dall, 1908

Grant & Gale (1931, p. 508) have pointed out that there is no obvious distinction between *Aforia* and *Irenosyrinx*. Dall (1889) stated that *Aforia* was without an operculum but according to Grant & Gale (loc. cit.) it has since been shown to have one. The type of *Aforia* is from the Bering Sea in deep water and that of *Irenosyrinx*, *Pleurotoma* (*Leucosyrinx*) *goodei* Dall, is from north-west of Patagonia in 1050 fathoms.

Aforia magnifica (Strebel)

Surcula magnifica Strebel, 1908, p. 19, pl. 2. fig. 23*a–d*.

TYPE LOCALITY. South-west of Snow Hill I., 64° 20′ S, 56° 38′ W, 150 m.

St. 182. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W, 14 Mar. 1927, 278–500 m.
St. 195. Admiralty Bay, King George I., South Shetland Is., 62° 07′ S, 58° 28′ 30″ W, 391 m.
St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m.
St. 1952. Between Penguin I. and Lion's Rump, King George I., South Shetland Is., 11 Jan. 1937, 367–382 m.

Height 63·0 mm.; diameter 22·8 mm. (holotype).
Height 63·0 mm.; diameter 22·0 mm. (St. 195).

DENTITION. Fig. M, 91, p. 195. St. 182. 1+0+1+0+1. Central tooth large and broad with a convex upper margin and a single small cusp in the centre. The single series of marginals are composed of large approximately shuttle-shaped teeth, tapered to a single point, and without serrations or denticles. The absence of laterals has enabled a great increase in the size and lateral spread of the central.

A very similar type of radula is found in *Ptychosyrinx bisinuata* (Martens) (Thiele, 1931, p. 359) and *Leucosyrinx crispulata* Martens (Thiele, loc. cit.).

This species and *Fusitriton cancellatum*, both of which belong to groups with an extensive western American range, show how the continuity of the western coasts of the Americas has been and still is a supply route to the Antarctic waters of the Weddell Quadrant.

Aforia goniodes (Watson)

Pleurotoma clara Martens, 1880, 35, pl. 8, fig. 1 (non *Pl. clara* Reeve, 1845).
Pleurotoma (*Surcula*) *goniodes* Watson, 1881, p. 394.
Pleurotoma (*Surcula*) *goniodes* Watson, 1886, pl. 20, fig. 4.
Leucosyrinx goniodes (= *clara*) Martens & Thiele, 1903, p. 90.

TYPE LOCALITIES. Patagonia, 60 fathoms (*clara*); south-east of Rio de la Plata, Argentina, 600 fathoms (*goniodes*).

St. WS 867. Between Falkland Is. and Grande Bay, Patagonia, 51° 10′ S, 64° 15·5′ W, 30 Mar. 1932, 150–147 m.

One empty shell, 37 × 15 mm.

Genus **Leucosyrinx** Dall, 1889

Type (o.d.): *Pleurotoma verrilli* Dall, North Carolina to Gulf of Mexico. 150–850 fathoms

I have included the two following species in *Leucosyrinx* in preference to *Aforia* because the anal sinus is broad, occupying most of the shoulder, and the species lack the strong peripheral carina which is so characteristic of *Aforia*. Unfortunately, none of the specimens contained the animal. Both *Aforia* and *Leucosyrinx* belong to the subfamily Cochlespirinae.

Leucosyrinx paratenoceras n.sp., Pl. IX, fig. 54

Shell large, elongate fusiform, with a long, slender spire; lightly convex whorls, except for a concave shoulder; white, covered with a thin, shining, almost colourless, faintly iridescent epidermis and sculptured with closely spaced spiral cords, most of which finally become bifid. Whorls eight, including a smooth papillate protoconch of about two whorls with a small erect central nucleus. Spire tall and narrow, about $1\frac{1}{3}$ times height of aperture plus canal. Post-nuclear sculpture consisting of one or two weak spiral threads near the outer extremity of the otherwise smooth shoulder and seven or eight strong, flat-topped spiral cords between the shoulder angle and the lower suture. About twenty-six cords on the body-whorl plus about ten closely spaced fine threads on the fasciole. Most of the cords on the later whorls are bifurcated by linear grooves. There is no true axial sculpture apart from numerous irregular growth lines. Aperture elongate-oval and produced below into a relatively short and straight spout-like anterior canal. Sinus concave, occupying the whole of the shoulder. Outer lip

produced forwards in a considerable arcuate sweep. Parietal and columellar callus smooth, porcellanous, and abruptly marked off from the surface sculpture.

Height 38·75 mm.; diameter 11·5 mm. (St. 1952, holotype).

Height 43·5 mm.; diameter 13·0 mm. (St. 1957).

TYPE LOCALITY. St. 1952. Between Penguin I. and Lion's Rump, King George I., South Shetland, Is., 2 Jan. 1937, 367–382 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.

St. 175. Bransfield Strait, South Shetlands Is., 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.

St. 182. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W, 14 Mar. 1927, 278–500 m.

St. 1957. Off south side of Clarence I., 7 miles east of Cape Bowles, South Shetlands Is., 3 Feb. 1937, 785–810 m.

In its slender form the species resembles *Leucosyrinx tenoceras* Dall from off Gaudeloupe in 583 fathoms (1889*b*, p. 76, pl. 36, fig. 5).

Leucosyrinx paragenota n.sp., Pl. IX, fig. 56

Shell of similar shape and proportions to *paratenoceras*, but smaller, with finer and more numerous spiral cord-sculpture, the whole of the shoulder spirally lirate, a shorter anterior canal and a much more prominent fasciole. Whorls seven, including a rather large papillate protoconch of 1½ smooth whorls plus a brephic half-whorl of closely spaced sinuous axials. Post-nuclear sculpture consisting of closely spaced spirals crossed by numerous oblique axials. Five weak spiral threads on the narrow concave shoulder, nine to fourteen flat-topped, linear-spaced cords from the shoulder to the lower suture, and about thirty-six on the body whorl from the shoulder to the fasciole, which bears approximately a further fourteen spirals, but they are closely spaced, weak and ill-defined threads. Axials narrow, protractively oblique and extending from the shoulder to the lower suture, eighteen to twenty per whorl, but subobsolete on the body-whorl. Aperture narrow, with a very short, spout-like anterior canal. Anal sinus deeply concave, occupying the whole of the shoulder. Outer lip produced forwards in a considerable arcuate sweep. Fasciole prominently bulging, commencing above the middle of the aperture. Parietal and columellar callus smooth and porcellanous, abruptly marked off from the external sculpture and not interrupted by the fasciole. Colour white, covered with a thin, buff-coloured epidermis.

Height 21·25 mm.; diameter 7·5 mm. (holotype, St. 652).

TYPE LOCALITY. St. 652. Burdwood Bank, south of Falkland Is., 54° 04′ S, 61° 40′ W, 14 Mar. 1931, 171–169 m. PROTOCONCH. Fig. N, 113, p. 196.

Leucosyrinx falklandica n.sp., Pl. IX, fig. 55

Shell very similar to *paragenota*, but with a larger, more bulbous protoconch, a smooth shoulder and an inconspicuous fasciole. Whorls six, including a large, bluntly rounded smooth protoconch of two whorls, followed by a half-whorl of closely spaced, strong, brephic axials. Post-nuclear spiral sculpture consisting of flat-topped, linear-spaced, spiral cords, extending from the shoulder to the lower suture, nine to eleven on the spire-whorls and about forty on the body-whorl including the ill-defined fasciole. Axials prominent, protractively oblique, commencing at the shoulder, but becoming obsolete towards the lower suture and on the last half-whorl. Colour white, covered by a pale buff epidermis. Apertural features and sinus as in the above two species.

Height 15·75 mm.; diameter 5·8 mm.

TYPE LOCALITY. St. WS 871. North of Falkland Is., 53° 16′ S, 64° 12′ W, 1 Apr. 1932, 336–342 m. (one example only). PROTOCONCH. Fig. N, 112, p. 196.

Genus **Belaturricula** n.g.

Type: *Bela turrita* Strebel

This genus is provided for a large narrowly fusiform species with a tall spire, a bluntly rounded, paucispiral smooth protoconch, a short straight spout-like anterior canal and a very shallow Turriculid style of anal sinus, with the outer lip very little produced and parallel to the axis of the shell. The dentition is not known, nor has it been determined if an operculum is present or not.

The type species seems to be very similar to Watson's *Pleurotoma* (*Surcula*) *dissimilis* (1886, p. 298, pl. 26, fig. 3) from south-east of the Philippine Islands in 500 fathoms.

Strebel's shell has no resemblance to '*Bela*' auct., which name has long served as a dumping ground for species of uncertain affinity.

The sinus in the St. 159 example, recorded below, although shallow, is much more distinct than shown in Strebel's figure.

Belaturricula turrita (Strebel)

Bela turricula Strebel, 1908, p. 18, pl. 3, fig. 32*a–c*.

TYPE LOCALITY. Shag Rock Bank, west of South Georgia, 53° 34′ S, 43° 23′ W, 160 m.

St. 159. Off Cumberland Bay, South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.

One empty shell, 50 × 17·5 mm., compared with 60 × 21 mm. for Strebel's holotype.

Genus **Conorbela** n.g.

Type: *Bela antarctica* Strebel

A new genus is required for this shell, which has little in common with the several other Antarctic and Subantarctic species ascribed to '*Bela*' auct. by Strebel (1908).

The shell is comparatively large, thin and ovate-biconic with a prominent, flat, sloping shoulder defined by a rounded peripheral keel. The protoconch, so far as can be judged from available material, is relatively large, dome-shaped and paucispiral. The anterior canal is spout-like, very little produced but slightly constricted by a spiral termination to the smooth, arcuate columella. The posterior sinus is a broad, very shallow arc extending from the suture to the peripheral keel. The operculum is irregularly ovate, with a terminal nucleus, vestigial, occupying only a third the linear dimensions of the aperture. No radula was located.

The form of the sinus suggests relationship with the Conorbiinae and the presence of an operculum disassociates it from *Gymnobela*, the only other Turrid genus of similar form. Except for the lack of columellar plaits and the shallow but definite posterior sinus, *Conorbela* resembles the Cancellarid *Admete carinata* Watson and the Volutid, *Paradmete percarinata* n.sp.

Conorbela antarctica (Strebel)

Bela antarctica Strebel, 1908, p. 16, pl. 3, fig. 30*a*, *b*.

TYPE LOCALITY. South-west of Snow Hill I., 64° 36′ S, 57° 42′ W, 125 m.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m. (one old eroded shell).

St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m. (three living but somewhat eroded examples).

Genus Lorabela n.g.

Type: *Bela pelseneri* Strebel

Bartsch (1941) reviewed the Boreal Turrids of the groups previously ascribed to *Bela*, *Lora*, *Oenopota* and *Propebela* and proposed ten new genera and subgenera. He explained, as I did, independently (Powell, 1942, pp. 9, 12 and 16), that *Bela* Gray, 1847, applies to the Mangeliinae and *Lora* Gistel, 1848, was proposed as a n.nom. for the preoccupied *Defrancia* Millet, 1826 = *Pleurotomoides* Bronn, 1831, an Italian Miocene member of the Mangeliinae. The available names for the '*Bela*' auct. shells are thus restricted to *Oenopota* Moerch, 1852, *Propebela* Iredale, 1918, and the ten new propositions of Bartsch.

A group of Antarctic shells, typified by the South Georgian *Bela pelseneri*, resembles the boreal *Propebela* in build and adult sculptural plan of strong axials crossed by regular spiral cords, but has a smooth, paucispiral protoconch and a deep rounded anal sinus occupying the shoulder.

The protoconch in *Propebela* has a smooth initial whorl followed by one bearing spiral threads and finally a brephic stage with the spirals crossed by weak, closely spaced axial riblets. The anal sinus is so shallow that it is scarcely apparent.

The genotype of *Lorabela* has a vestigial, thin, oval operculum with a terminal nucleus and radula very similar to that of *Propebela turricula*, which consists of bundles of slender, twisted rods.

Lorabela pelseneri (Strebel, 1908)

Bela pelseneri Strebel, 1908, p. 15, pl. 2, fig. 27 *a*, *b*.

TYPE LOCALITY. Cumberland Bay, 252–310 m., South Georgia.

St. 45. 2·7 miles S 85° E of Jason Lt., South Georgia, 6 Apr. 1926, 238–270 m.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.

Lorabela notophila (Strebel)

Bela notophila Strebel, 1908, p. 16, pl. 2, fig. 28*a*, *b*.

TYPE LOCALITY. Cumberland Bay, 252–310 m., South Georgia.

St. 123. Off mouth of Cumberland Bay, South Georgia, from 4·1 miles N 54° E of Larsen Point to 1·2 miles S 62° W of Merton Rock, 15 Dec. 1926, 230–250 m.

St. 149. Mouth of East Cumberland Bay, South Georgia, from 1·15 miles N 76½° W to 2·62 miles S 11° W of Merton Rock, 10 Nov. 1927, 200–234 m.

St. WS 27. Off northern end of South Georgia, 53° 55′ S, 38° 01′ W, 19 Dec. 1926.

PROTOCONCH. Fig. N, 114, p. 196.

Lorabela plicatula (Thiele)

Bela plicatula Thiele, 1912, p. 215, pl. 14, fig. 4.

TYPE LOCALITY. St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

Genus Belalora n.g.

Type: *Belalora thielei* n.sp.

This genus resembles *Propebela* in build and adult sculpture, but has a relatively larger, more dome-shaped protoconch consisting of a smooth planorbid tip, a whorl of closely spaced spiral threads and, finally, a whorl of spiral ribs crossed by axial threads. As in the previous genus, *Lorabela*, the posterior sinus is deep and rounded. There is a vestigial oval operculum with a terminal nucleus. Theile's *Bela striatula* (1912, p. 215, pl. 14, fig. 3), from Gauss Station, Davis Sea, belongs to this genus. It has the same style of protoconch as *thielei*, but the post-nuclear axials are more numerous.

Belalora thielei n.sp., Pl. VI, fig. 20

Shell small, biconic, with turreted spire and sculptured with strong axials and dense spiral lirations. Whorls six, including a relatively large, bulbous to dome-shaped sculptured protoconch of three whorls, as described above. Spire equal to height of aperture plus canal. Spire-whorls with a prominent slightly concave shoulder; outline steep from below the shoulder and sculptured with prominent, bluntly rounded, slightly protractively oblique axials, fourteen on the penultimate and fifteen on the body-whorl. All post-nuclear whorls crossed by dense spiral lirations, six to eight weak spirals on the shoulder and twelve strong spirals from the shoulder to the lower suture of the spire-whorls. Body-whorl, including base, with about fifty-eight spirals, much finer on the shoulder, the fasciole, and neck. Aperture narrowly ovate-pyriform with a short, broad anterior canal and a deeply concave posterior sinus, occupying the shoulder. Inner lip strengthened by a massive, smooth, rounded parietal-columellar callus, which is separated from the base by a narrow excavated area. There is a conspicuous, bulging fasciole.

Height 7·1 mm.; diameter 3·7 mm. (holotype, St. WS 801).

Type locality. St. WS 801. North-west of Falkland Is. to Patagonia, 48° 26′ 15″ S, 61° 28′ W, 22 Dec. 1931, 165–165 m.

St. WS 216. North of Falkland Is., 47° 37′ S, 60° 50′ W, 1 June 1928, 219–133 m.
St. WS 797. North-west of Falkland Is. to Patagonia, 51° 06′ S, 64° 10′ 30″ W. to 47° 47′ 43″ S, 64° 07′ 30″ W, 19 Dec. 1931, 117 m.
St. WS 808. From 49° 41′ S, 65° 40′ W to 49° 39·5 S, 65° 44′ W, 8 Jan. 1932, 110–106 m.

Protoconch. Fig. N, 115, p. 196.

Genus Pleurotomella Verril, 1873

Type (monotypy): *Pleurotomella packardi* Verril Recent, north-east coast of U.S.

The first species recorded below has a three-whorled, conical, pale brownish, 'sinusigerid' protoconch, a Daphnellid reversed L-shaped sinus and general features closely similar to the north-east American genotype. Dall (1889*b*, pp. 119–26) has described or recorded a number of deep-water species from the West Indies. He accounts for the presence of two types of protoconch in the genus by a suggestion that the smooth, shelly nucleus is an infilling of a horny 'sinusigerid' envelope which has subsequently weathered away (loc. cit. p. 124).

The remaining two species recorded below have this blunt, white, shelly, few-whorled protoconch, and the *ohlini* material, several of which contain the animal, resemble typical *Pleurotomella* in the lack of an operculum.

Pleurotomella simillima Thiele

Pleurotomella simillima Thiele, 1912, p. 216, pl. 14, fig. 8.

Type locality. Gauss Station, Davis Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m. (one empty shell).

Protoconch. Fig. N, 117, p. 196.

Pleurotomella? ohlini (Strebel)

Thesbia ohlini Strebel, 1905*b*, p. 592, pl. 22, figs. 22, 22*a*.

Type locality. Fortescue Bay, 10–12 fathoms, Strait of Magellan.

St. WS 212. North of Falkland Is., 49° 22′ S, 60° 10′ W, 30 May 1928, 242 m.
St. WS 228. North-east of Falkland Is., 50° 50′ S, 56° 58′ W, 30 June 1928, 229–236 m.
St. WS 244. West of Falkland Is., 52° S, 62° 40′ W, 8 July 1928, 253–247 m.

Protoconch. Fig. N, 116, p. 196.

Pleurotomella? anomalapex n.sp., Pl. VI, fig. 19

Shell small, white, fusiform with strongly convex and weakly shouldered whorls, sculptured with dense, wavy, spiral lirations and protractively arcuately oblique axials. Whorls five, including a blunt paucispiral, smooth protoconch of two whorls. Spire-whorls sculptured with ten to twelve spirals, body-whorl including base and neck with about forty-spirals, shoulder without spirals. Axial sculpture of narrowly rounded, oblique axials, which commence strongly at the shoulder, but become subobsolete over the lower half of the whorls. There is a weak surface pattern also, of dense axial threads which are more apparent on the otherwise smooth concave shoulder. The posterior sinus is deep, Daphnellid reversed L-shaped, and the outer lip swings forward in an arcuate sweep. The anterior canal is sharp and comparatively straight, its length emphasized by the relatively long neck, resulting from an excavated base.

Height 7·8 mm.; diameter 3·9 mm.

TYPE LOCALITY. St. WS 225. Between Falkland Is. and Patagonia, 50° 20′ S, 62° 30′ W, 9 June 1928, 162–161 m. (holotype only).

The species resembles *ohlini*, but has the addition of well-developed axials. Although both these species lack the sinusigerid protoconch of the genotype, the adult characters of build and sinus are in accord with *Pleurotomella*. I have already referred to Dall's view that some Turrids commence with a horny sinusigerid envelope which wears off and leaves a limy mould in its place. The somewhat irregular shape and minute surface malleations of the nucleus in two of the above species, and especially the raised terminal varix, seem to be in accord with Dall's explanation.

Genus **Eumetadrillia** Woodring, 1928

Type (o.d.): *Agladrillia* (*Eumetadrillia*) *serra* Woodring Miocene, Jamaica

The shells which I have referred below to Smith's unfigured *fuegiensis* seem to represent the adult of that species. They certainly tally with Smith's description better than they do with any other Magellanic '*Drillia*' known to me, and most of them have been adequately figured by Strebel (1905, 1908).

The shells before me match Smith's description in every particular—protoconch, number and very oblique trend of the axials, which are thickest above, smooth concave shoulder, aperture two-fifths the total height, sinus deep, and even the purplish pink colour. Also, young examples approximate to the dimensions cited by Smith.

The generic location seems to fall between the Recent and Tertiary Austro-Neozelanic *Splendrillia* Hedley, 1922, and Woodring's *Eumetadrillia*, with more leaning towards the latter.

The protoconch is large, broad and dome-shaped as in *Splendrillia*, but the shoulder is entirely free from the subsutural spiral fold which is so characteristic of that genus. Although the protoconch in *Eumetadrillia* is rather slender the smooth concave shoulder and general features of build and axial ribbing are in accord with those features in the Magellanic shell.

Most of the 'Discovery' shells have a very weak parietal callus, but in one aged example this feature is quite as well developed as in Woodring's genotype.

Eumetadrillia fuegiensis (Smith)

Pleurotoma (*Surcula*) *fuegiensis* Smith, 1888, p. 300.

TYPE LOCALITY. Strait of Magellan.

St. WS 85. 8 miles S 66° E of Lively I., East Falkland Is., 52° 09′ S, 58° 14′ W to 52° 08′ S, 58° 09′ W 25 Mar. 1927, 79 m.

St. WS 88. Off north of Staten I., 54° S, 64° 57′ 30″ W, 6 Apr. 1927, 118 m.

St. WS 95. Between Falkland Is. and Patagonia, 48° 57′ S, 64° 45′ W to 48° 59′ 30″ S 64° 45′ W, 17 Apr. 1927, 109–108 m.
St. WS 222. Between Falkland Is. and Patagonia, 48° 23′ S, 65° W, 8 June 1928, 100–106 m.
St. WS 243. Between Falkland Is. and Patagonia, 51° 06′ S, 64° 30′ W, 17 July 1924, 144–141 m.
St. WS 764. Between Falkland Is. and Argentina, 44° 38′ 15″ S, 61° 58′ 30″ W, 17 Oct. 1931, 110–104 m.
St. WS 787. Off Patagonia, 48° 44′ S, 65° 24′ 30″ W, 7 Dec. 1931, 106–110 m.
St. WS 808. Off Santa Cruz, Patagonia, 49° 40′ 15″ S, 65° 42′ W, 8 Jan. 1932, 109–107 m.
St. WS 838. Between Falkland Is. and Tierra del Fuego, 53° 11′ 45″ S, 65° W, 5 Feb. 1932, 148 m.

Height 11·5 mm.; diameter 4·0 mm. (holotype).
Height 10·5 mm.; diameter 4·25 mm. (St. WS 95).
Height 17·5 mm.; diameter 6·25 mm. (St. WS 243).
Height 20·3 mm.; diameter 6·5 mm. (St. WS 88).

PROTOCONCH. Fig. N, 118, p. 196.

Genus **Typhlodaphne** n.g.

Type: *Bela purissima* Strebel, 1908

The relationships of this genus are puzzling. It has a bluntly rounded, smooth, paucispiral protoconch of two whorls, with an asymmetrical nucleus, a type found in any of the subfamilies. The sinus is most like that of *Daphnella* in being subsutural, steeply descending and then produced forward at an angle to meet the arcuately produced outer lip, but the presence of an operculum is foreign to the Daphnellinae. The dentition consists of paired marginals only, of the awl-shaped Conid type, not the hilted dagger form, characteristic of the '*Bela*' complex, but very similar to those of *Phenatoma* (Clavinae).

In several respects, shape, sinus and dentition, *Typhlodaphne* closely resembles *Typhlosyrinx vepallida* Martens, 1903, from 1840 m. in the Gulf of Aden, but that genus lacks an operculum and has a globular initial whorl to its smooth, paucispiral protoconch.

Since the only important difference between *Typhlodaphne* and *Typhlosyrinx* is the presence of an operculum in the former and its absence in the latter, I feel that the placing of a high taxonimic value upon the presence or absence of an operculum would sever what appears to be rather close relationship. Admittedly one of the criteria used in the segregation of the Mangeliinae and the Daphnellinae is the absence of an operculum, but in the case of *Typhlodaphne* the operculum is of vestigial size and may well reflect an archaic condition just as some members of the Clavinae preserve the prototypic complete dental formula of central, lateral and marginal teeth.

Both *Typhlodaphne* and *Typhlosyrinx* are here referred to the Daphnellinae mainly on the evidence of the sinus, which is of a type seemingly excusive to that subfamily.

Typhlodaphne purissima (Strebel)

Bela purissima Strebel, 1908, p. 17, pl. 3, fig. 31 *a–d*.

TYPE LOCALITY. Off Shag Rocks, west of South Georgia, 160 m.

St. 159. Off Cumberland Bay, South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m.
St. 160. Near Shag Rocks, west of South Georgia, 53° 43′ 40″ S, 40° 57′ W, 7 Feb. 1927, 177 m.

DENTITION. Fig. M, 92, p. 195 (St. 159).

PROTOCONCH. Fig. N, 119. OPERCULUM. Fig. N, 130, p. 196.

Typhlodaphne strebeli n.sp., Pl. IX, fig. 53

This species differs from the glossy, milk-white *purissima* in being uniformly warm-buff, more slender, with a smaller protoconch and with flexuous, subobsolete axials over all post-nuclear whorls. Shell elongate ovate-fusiform, with a tall spire, slightly less than height of aperture plus canal. Whorls

$6\frac{1}{2}$, including a small, smooth, papillate protoconch of $1\frac{1}{2}$ whorls. Post-nuclear sculpture of narrow, flexuous, protractive, closely spaced axials, commencing just below the slightly concave shoulder, but becoming subobsolete towards the lower suture and on the base of the body-whorl. The axials number from eighteen to twenty-four on the spire-whorls. Sinus subsutural, occupying the shoulder, steeply descending at first and then produced forwards in the arcuate sweep of the outer lip. Aperture narrowly ovate with a rounded, broadly channelled anterior end not constricted and scarcely differentiated. Surface with numerous microscopic spiral lirations, not distinct enough to be counted.

Height 20·0 mm.; diameter 7·25 mm. (holotype).

Height 24·5 mm.; diameter 10·0 mm. (St. 160 = topotype of *purissima*).

TYPE LOCALITY. St. 388. Between Cape Horn and Staten I., 56° $19\frac{1}{2}$′ S, 67° $09\frac{3}{4}$′ W, 16 Apr. 1930, 121 m.

Typhlodaphne translucida (Watson)

Pleurotoma (*Thesbia*) *translucida* Watson, 1881, p. 444.
Pleurotoma (*Thesbia*) *translucida* Watson, 1886, p. 330, pl. 25, fig. 11.
Thesbia translucida Thiele, 1912, p. 248.

TYPE LOCALITY. Half-way between Marion I. and Prince Edward I., 140 fathoms.

St. 1563. Between Marion I. and Prince Edward I., 46° 48·4′ S, 37° 49·2′ E, 7 Apr. 1935, 113–99 mm. (one empty shell).

Typhlodaphne filostriata (Strebel)

Thesbia filostriata Strebel, 1905*b*, p. 591, pl. 22, figs. 21, 21*a*.

TYPE LOCALITY. Borja Bay, 10 fathoms, Strait of Magellan.

St. 388. Between Cape Horn and Staten I., 56° $19\frac{1}{2}$′ S, 67° $09\frac{3}{4}$′ W, 16 Apr. 1930, 121 m. (two empty shells).

Family ACTEONIDAE

Genus **Acteon** Montfort, 1810

Type (monotypy): *Acteon tornatilis* Montfort (= *Voluta tornatilis* Linn.)

Acteon bullatus (Gould)

Tornatella bullata Gould, 1847, p. 251.
Actaeon bullatus Tryon & Pilsbry, 1893, p. 163, pl. 49, figs. 10, 11.

TYPE LOCALITY. Off Patagonia.

St. WS 71. 6 miles N 60° E of Cape Pembroke Lt., East Falkland Is., 51° 38′ S, 57° 32′ 30″ W, 23 Feb. 1927, 82–80 m.
St. WS 80. Between Falkland Is. and Patagonia, 50° 57′ S, 63° 37′ 30″ W, 14 Mar. 1927, 152 m.
St. WS 854. Off Patagonia, 45° 16′ S, 64° 25′ W, 22 Mar. 1932, 97 m.
St. WS 856. Off Patagonia, 46° 35′ S, 64° 11′ W, 23 Mar. 1932, 104 m.

Acteon antarcticus Thiele

Actaeon antarcticus Thiele, 1912, p. 219, pl. 14, fig. 17.

TYPE LOCALITY. Gauss Station, 380 m. Davis Sea.

St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m.
St. 175. Bransfield Strait, South Shetland Is. 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.

Genus Neactaeonina Thiele, 1912

Type (o.d.): *Actaeonina cingulata* Strebel

Neactaeonina cingulata (Strebel)

Actaeonina cingulata Strebel, 1908, p. 8, pl. 2, fig. 17*a–c*.
Neactaeonina cingulata Thiele, 1912, p. 219.

TYPE LOCALITY. South Georgia, 24–52 m.

St. 159. Off South Georgia, 53° 52′ 30″ S, 36° 08′ W, 21 Jan. 1927, 160 m. (one example).
St. 170. Off Cape Bowles, Clarence I., 61° 25′ 30″ S, 53° 46′ W, 23 Feb. 1927, 342 m. (one example).

DENTITION. Thiele (1912, loc. cit., text-figs. 4, 5).

Neactaeonina edentula (Watson)

Actaeon edentulus Watson, 1883, p. 284.
Actaeon (*Actaeonina*) *edentulus* Watson, 1886, p. 632, pl. 47, fig. 6.
Neactaeonina edentula Thiele, 1912, p. 219.

TYPE LOCALITY. Balfour Bay, 60 fathoms, Royal Sound, Kerguelen I.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m. (one example).
St. 195. Admiralty Bay, King George I., South Shetland Is., 62° 07′ S, 58° 28′ 30″ W, 30 Mar. 1927, 391 m. (one example).

Height 25·2 mm.; diameter 12·75 mm. (holotype).
Height 16·5 mm.; diameter 10·5 mm. (St. 144).

DENTITION. Unfortunately, the teeth became scattered in the only mount I was able to prepare, but individually they resemble those figured by Thiele for *cingulata*.

The South Georgian example (St. 144) is slightly more globose than the type, and if this feature should prove to be constant a new species is indicated.

Neactaeonina fragilis Thiele

Neactaeonina fragilis Thiele, 1912, p. 219.
Neactaeonina fragilis Hedley, 1916, p. 63.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

Hedley (1916) recorded the species from off Adelie Land, 66° 52′ S, 145° 30′ E in 288 fathoms.

Genus Toledonia Dall, 1902

Type (o.d.): *Toledonia perplexa* Dall, 1902, Strait of Magellan = *Odostomiopsis* Thiele in Martens & Thiele, 1903 = *Ohlinia* Strebel, 1905, Type (monotypy): *Admete? limnaeaeformis* Smith

Toledonia limnaeaeformis (Smith)

Admete? limnaeaeformis Smith, 1879, p. 172, pl. 9, fig. 4.
Odostomiopsis typica Martens & Thiele, 1903, p. 68, pl. 7, fig. 27.
Ohlinia limnaeaeformis Strebel, 1905*b*, p. 597, pl. 21, fig. 32 (only).
Toledonia limnaeaeformis Thiele, 1912, p. 249.

TYPE LOCALITY. Kerguelen I. (*limnaeaeformis* and *typica*).

St. WS 88. North of Le Maire Strait, Tierra del Fuego, 54° S, 64° 57′ 30″ W, 6 Apr. 1927, 118 m.

Toledonia perplexa Dall

Toledonia perplexa Dall, 1902*b*, p. 513.
Ohlinia limnaeaeformis Strebel, 1905*b*, p. 597, pl. 21, fig. 32*a* (only).

TYPE LOCALITY. East of Punta Arenas, 61 fathoms, Strait of Magellan.

St. 53. Port Stanley, East Falkland Is. on hulk 'Great Britain', 12 May 1926, 0–2 m.

Dall's species was synonymized with *limnaeaeformis* by Thiele (1912), but it seems to be a stable species of globose outline and with a very short spire. The St. 53 examples have the same dimensions as *perplexa* (3·2 × 2·3 mm.; aperture 2·2 mm. in height) and correspond to Strebel's (1905, loc. cit. pl. 22) fig. 32*a* from Hope Harbour, 6–10 fathoms, Patagonia.

Toledonia punctata Thiele

Toledonia punctata Thiele, 1912, p. 249, pl. 14, fig. 23.

TYPE LOCALITY. Observatory Bay, Kerguelen I.

St. 144. Off Mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.

Toledonia globosa Hedley

Toledonia globosa Hedley, 1916, p. 63, pl. 9, fig. 101.

TYPE LOCALITY. Off Mertz Glacier Tongue, 66° 55′ S, 145° 21′ E, 288 fathoms.

St. 1652. Ross Sea, 75° 56·2′ S, 178° 35·5′ W, 23 Jan. 1936. 567 m.
St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

Tomlin (1948, p. 229) recorded this species from 69 metres off Macquarie Island.

Toledonia major (Hedley)

Odostomiopsis major Hedley, 1911, p. 6, pl. 1, figs. 9, 10.

TYPE LOCALITY. Cape Royds.

St. 175. Bransfield Strait, South Shetland Is., 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.

One small example, 4·0 × 2·25 mm., but of identical shape and the same style of protoconch as the type, which measures 6 × 4 mm.

Family PHILINIDAE

Genus **Philine** Ascanius, 1772

Type: *Philine aperta* Linn.

Philine alata Thiele

Philine alata Thiele, 1912, p. 220, pl. 14, figs. 19, 20.

TYPE LOCALITY. Gauss Station, Davis Sea.

St. 163. Paul Harbour, Signy I., South Orkney Is., 17 Feb. 1927, 18–27 m.
St. 175. Bransfield Strait, South Shetland Is., 63° 17′ 20″ S, 59° 48′ 15″ W, 2 Mar. 1927, 200 m.
St. 187. Neumayr Channel, Palmer Archipelago, 64° 48′ 30″ S, 63° 31′ 30″ W, 18 Mar. 1927, 259 m.
St. 363. 2·5 miles S 80° E of south-east point of Zavodovski I., South Sandwich Is., 26 Feb. 1930, 329–278 m.
St. 1872. Scotia Sea, 63° 29·6′ S, 54° 03·1′ W, 12 Nov. 1936, 247 m.

Philine gibba Strebel

Philine gibba Strebel, 1908, p. 13, pl. 2, fig. 22.

TYPE LOCALITY. South Georgia, 20 m.

St. WS 32. Mouth of Drygalski Fjord, South Georgia, 21 Dec. 1926, 225 m., 329–278 m.

Philine cf. **kerguelensis** Thiele

Philine kerguelensis Thiele, 1925, p. 279 (245), pl. 32, figs. 22, 22*a*.

TYPE LOCALITY. Kerguelen I.

St. WS 219. North-west of Falkland Is., 47° 06′ S, 62° 12′ W, 3 June 1928, 116–114 m.

Height 2·8 mm.; diameter 2·0 mm. (holotype).
Height 6·0 mm.; diameter 4·2 mm. (St. WS 219).

The shells from St. WS 219 seem to represent fully grown examples of Thiele's species, which is rather distinctive with its planorbid spire, finely spirally punctate surface striations and rather deep posterior sinus.

The animal exhibits the usual Philinid characteristics of a large, oblong, head disk without eyes or tentacles, and three large lozenge-shaped calcareous gizzard plates. These plates have a sharply raised cigar-shaped external central area surrounded by a rounded rim; the inner surface is plain and convex. The plates are enormous for the size of the animal, 4 mm. long in an animal with a shell of 6 mm. height.

DENTITION. Fig. M, 95, p. 195. The radula consists of the first lateral only, which is claw-shaped with minute serrations on the concave side. These laterals are very similar in form and detail to those of the genotype. Some species of *Philine* have the addition of up to six marginals.

Philine falklandica n.sp., Pl. VII, fig. 24

Shell small, white, semi-pellucid, ovate-rhomboidal with a very large aperture; outer lip slightly taller than the spire and reaching the sunken inrolled apex by a broadly convex but deeply sinused curve; basal lip broad and flattened. Dorsally there is a slight constriction just below the shoulder. The surface is delicately sculptured with dense, very regular, minutely granulated, axial lirations.

Height 4·9 mm.; diameter 3·9 mm. (holotype).

TYPE LOCALITY. St. WS 219. Between Falkland Is. and Patagonia, 47° 06′ S, 62° 12′ W, 3 June 1928, 116 m.

St. WS 210. North of Falkland Is., 50° 17′ S, 60° 06′ W, 29 May 1928, 161 m.
St. WS 215. North of Falkland Is., 47° 37′ S, 60° 50′ W, 31 May 1928, 219 m.
St. WS 225. Between Falkland Is and Patagonia, 50° 20′ S, 62° 30′ W, 9 June 1928, 162 m.

The distinctive axial sculpture should make this species easily recognizable. The calcareous gizard plates are minute, irregularly oval bodies only 0·4 mm. long in a shell measuring 5·4 × 3·9 mm.

DENTITION. Fig. M, 94, p. 195. There is no central tooth but a massive hooked lateral with minute serrations along the median section of the upper cutting edge and two moderately large marginals shaped like conventional finger-pointers.

Family SCAPHANDRIDAE

Genus **Kaitoa** Marwick, 1931

Type (o.d.): *Kaitoa haroldi* Marwick

Apart from much weaker spiral sculpture the South Georgian species described below has the essential shell characteristics of the New Zealand Miocene *Kaitoa*. The dentition shows that it is not far removed from the Boreal *Bullinella alba* (Brown).

Both genera are cylindrical with an involute spire, but *Kaitoa* resembles *Scaphandra* in having a smooth, concave columella, margined by a deep groove, and *Bullinella* (= *Cylichna*) has a slightly twisted, more or less vertical columella bearing a single oblique plait.

The radula of *Bullinella alba* consists of a small bilobed central tooth with a serrated apical cutting edge, a massive hooked lateral with a median ridge of small denticles and five small hooked smooth marginals. In *Kaitoa scaphandroides* there are only two marginals and none of the teeth bear serrations or denticles. The central varies greatly in form and shows evidence of considerable wear; it is normally composed of two slightly overlapping convex ridged plates on a rectangular base. The lateral is massive and robustly hooked and the two marginals are much smaller with long flexed hooks. The laterals in *Scaphandra* are long, slender and incurved like mammalian ribs.

Kaitoa scaphandroides n.sp., Pl. X, figs. 69, 70

Shell relatively large, cylindrical, with involute spire, the concave apex callused by an effuse extension of the outer lip. Surface smooth except for axial growth lines and subobsolete, sparse spiral lirations. Shell white, covered with a thick, dark, reddish brown epidermis. Outer lip thin, straight and slightly protractive medially, truncated and broadly open below. Aperture narrow above but considerably expanded below. Inner lip with a relatively broad callus which becomes thick over the concave columella. There are no plaits, but the columellar callus is bordered by a groove followed by a narrowly arched ridge.

Height 19·2 mm.; diameter 8·0 mm. (holotype, St. 30).

Height 23·0 mm.; diameter 9·2 mm. (St. 30).

TYPE LOCALITY. St. 30. West Cumberland Bay, South Georgia, 2·8 miles S 24° W. of Jason I., 16 Mar. 1926, 251 m.

St. WS 62. Wilson Harbour, South Georgia, 19 Jan. 1927, 26–83 m.

DENTITION. Fig. M, 93, p. 195.

There is a conical ferruginous deposit on the spire of the paratype.

Genus **Cylichnina** Monterosato, 1884

Type (s.d. Cossmann, 1895): *Cylichna strigella* Loven. (= *Bulla umbilicata* Montagu) Mediterranean

Cylichnina georgiana Strebel

Cylichnina georgiana Strebel, 1908, p. 10, pl. 2, fig. 20*a–c*.

TYPE LOCALITY. Cumberland Bay, South Georgia, 252–310 m.

St. 144. Off mouth of Stromness Harbour, South Georgia, from 54° 04′ S, 36° 27′ W to 53° 58′ S, 36° 26′ W, 5 Jan. 1927, 155–178 m.

Cylichnina cf. **gelida** (Smith)

Bullinella gelida Smith, 1907, p. 12, pl. 2, fig. 12.
Cylichna gelida Thiele, 1912, p. 220.

TYPE LOCALITY. 'Discovery' Winter Quarters, 130 fathoms, McMurdo Sound.

St. 1660. Ross Sea, 74° 46·4′ S, 178° 23·4′ E, 27 Jan. 1936, 351 m.

One immature example of 5 mm. height; the holotype is recorded as 13 × 7 mm. Thiele (1912) recorded an example 4 mm. in height from Gauss Station.

Genus **Diaphana** Brown, 1827

Type: *Retusa minuta* Brown

Diaphana paessleri (Strebel)

Retusa paessleri Strebel, 1905*b*, p. 577, pl. 22, figs. 34, 34*a*.

TYPE LOCALITY. Patagonia.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 115 m.

Family APLUSTRIDAE

Genus **Parvaplustrum** n.g.

Type: *Parvaplustrum tenerum* n.sp.

A minute, white, extremely fragile, *Haminea*-like shell occurred abundantly at depths between 100 and 320 m. in fourteen dredgings, mostly north and north-west of the Falklands.

It is a tectibranch of uncertain affinity, but probably lies nearest to Aplustridae. There are four cephalic tentacles, the outer two with a dorsal groove, rendering them almost auriculate, the inner two simple, no apparent eyes, a prominent bilobed proboscis and two protective shields to the head, the upper one formed by the mantle and its lower counterpart by a widening of the foot, which posteriorly tapers to a broadly V-shaped tail. The stomach plates are numerous, small, cartilaginous, more or less diamond-shaped bodies, which are closely grouped like paving stones (Fig. M, 98). The radula is a rake-like device composed of long, slender, arcuate rods (laterals), each with a shorter and even more slender forked member set directly underneath it (Fig. M, 96). The form of the gills could not be determined owing to the unsatisfactory preservation of the internal structures. The shell is lightly held along the outer edge of the aperture by a thin reflexion of the mantle, and even when the animal is fully expanded most of the shell is probably exposed. The animal is apparently completely retractive (Fig. M, 97, p. 195).

The presence of four cephalic tentacles suggests relationship with either *Aplustrum* or *Hydatina*, the only other tectibranchs, apart from *Pterygophysis* and the *Aplysiomorpha*, possessing two pairs of cephalic tentacles. The *Aplysiomorpha* have neither head disk nor dorsal shield and *Pteryophysis* has four conspicuous wing-like pleuropodial lobes. The stomach-plates resemble those of *Akera bullata* Mueller (Tryon & Pilsbry, 1893) but the radula is not comparable with that of any tectibranch known to me.

Not only a new genus but probably a new family is represented by this anomalous species, but I hesitate to erect a new family without recourse to better preserved material.

Parvaplustrum tenerum n.sp., Pl. VII, fig. 25

Shell minute, pure white, thin and extremely fragile. Ovate-globose. Body-whorl occupying full height of the shell. Aperture wide below, but somewhat constricted above. Spire a shallow cavity occupied by a low, convex, smooth protoconch of one translucent whorl. Outer lip thin, retracted to form a moderately deep sinus with a narrowly rounded termination; basal lip broadly arcuate. Sculpture consisting of extremely fine and dense spiral striations.

Height 2·8 mm.; diameter 2·15 mm. (shell of holotype, St. WS 219).

Type locality. St. WS 219. North-west of Falkland Is., 47° 06′ S, 62° 12′ W, 3 June 1928, 116–114 m.

St. 51. Off Eddystone Rock, East Falkland Is., from 7 miles N 50° E to 7·6 miles N 63° E of Eddystone Rock, 4 May 1926, 105–115 m.
St. WS 210. North of Falkland Is., 50° 17′ S, 60° 06′ W, 29 May 1928, 161 m.
St. WS 211. North of Falkland Is., 50° 17′ S, 60° 06′ W, 29 May 1928, 161–174 m.
St. WS 213. North of Falkland Is., 49° 22′ S, 60° 10′ W, 30 May 1928, 249–239 m.
St. WS 214. North of Falkland Is., 48° 25′ S, 60° 40′ W, 31 May 1928, 208–219 m.
St. WS 216. North of Falkland Is., 47° 37′ S, 60° 50′ W, 1 June 1928, 219–133 m.
St. WS 220. North-west of Falkland Is., 47° 56′ S, 62° 38′ W, 3 June 1928, 108–104 m.
St. WS 227. North-east of Falkland Is., 51° 08′ S, 56° 50′ W, 12 June 1928, 320–295 m.
St. WS 229. North-east of Falkland Is., 50° 35′ S, 57° 20′ W, 1 July 1928, 210–271 m.
St. WS 234. North of Falkland Is., 48° 52′ S, 60° 25′ W, 5 July 1928, 195–207 m.
St. WS 235. North of Falkland Is., 47° 56′ S, 61° 10′ W, 6 July 1928, 155–155 m.

St. WS 236. North of Falkland Is., 46° 55′ S, 60° 40′ W, 6 July 1928, 272–300 m.
St. WS 239. North-west of Falkland Is., 51° 10′ S, 62° 10′ W, 15 July 1928, 196–192 m.

DENTITION. Fig. M, 96, p. 195.

Family SIPHONARIIDAE

Genus Kergulenella Powell, 1946

n.nom. for *Kerguelenia* Rochebrune & Mabille, 1887 *non* Stebbing, 1888 (Crustacea)

Type: *Siphonaria lateralis* Gould, 1846

Kerguelenella lateralis (Gould)

Siphonaria lateralis Gould, 1846, p. 153.
Siphonaria rediniculum Reeve, 1856, pl. 5, fig. 24.
Siphonaria magellanica Philippi, 1857, p. 165.
Siphonaria lateralis Rochebrune & Mabille, 1889, p. 29.
Siphonaria lateralis Strebel, 1907, p. 172, pl. 3, figs. 27–29*a*.
Siphonaria (*Liriola*) *lateralis* Thiele, 1912, p. 250.
Siphonaria (*Kerguelenia*) *lateralis* Hubendick, 1946, p. 26, pl. 1, figs. 22–25.

TYPE LOCALITY. Burnt I., Orange Harbour, Strait of Magellan.

St. MS 70. Maiviken, west Cumberland Bay, South Georgia, 9 Mar. 1926, shore coll.

The 'Discovery' South Georgian specimens have low rounded ribs and are exactly as in Hubendick's figures of material from this same location. Topotypes, however, agree with Strebel's figures in having sharply raised radial ribs.

Hubendick has synonymized with *lateralis* my *macquariensis* (Powell, 1939, p. 238) from Macquarie Island. It is certainly nearer to South Georgian examples than to Tierra del Fuegan topotypes, but appears to differ from both in being constantly more elongate. Unfortunately no animals are available for study.

RANGE. Patagonia, Strait of Magellan, Falkland Is., South Georgia (Hubendick, 1946) and possibly Kerguelen I. Hubendick's Auckland, Campbell and Antipodes I. records refer to undescribed species and the Tasmanian record is most unlikely. An example from St. WS 123. Gough I., is too immature for exact determination.

Genus *Pachysiphonaria* Hubendick, 1945

Type (o.d.): *Siphonaria lessoni* Blainville

Pachysiphonaria lessoni (Blainville)

Siphonaria lessoni Blainville, 1824, p. 49.
Siphonaria lessoni Rochebrune & Mabille, 1889, p. 28.
Siphonaria (*Pachysiphonaria*) *lessoni* Hubendick, 1946, p. 26, pl. 1, figs 1–3.

TYPE LOCALITY. Falkland Is.

St. 54. Port Stanley, Falkland Is., 15 May 1926, shore coll.
Falkland Is. (A.W.B.P. coll. Auck. Mus.).
Comodoro Rividavia, Patagonia (A.W.B.P. coll. Auck. Mus.)

RANGE. West coast of South America below 12° S, Strait of Magellan, Graham Land, Patagonia, Argentina, Uruguay and Falkland Is. (Hubendick, 1946). Hubendick also adds with a query Kerguelen Island and Port Alfred, South Africa.

AMPHINEURA

Family LEPIDOCHITONIDAE

Genus **Icoplax** Thiele, 1892

Type (monotypy): *Chiton puniceus* Couthouy

Icoplax punicea (Gould)

Chiton puniceus Gould, 1846, p. 143.
Chiton illuminatus Reeve, 1847, pl. 22, fig. 147.
Callochiton illuminatus Melvill & Standen, 1914, p. 113.

Type localities. Orange Harbour, Patagonia (*puniceus*); Strait of Magellan (*illuminatus*).

St. WS 834. Off Bahia Grande, Patagonia, 52° 57′ 45″ S, 68° 08′ 15″ W, 2 Feb. 1932, 27–38 m.

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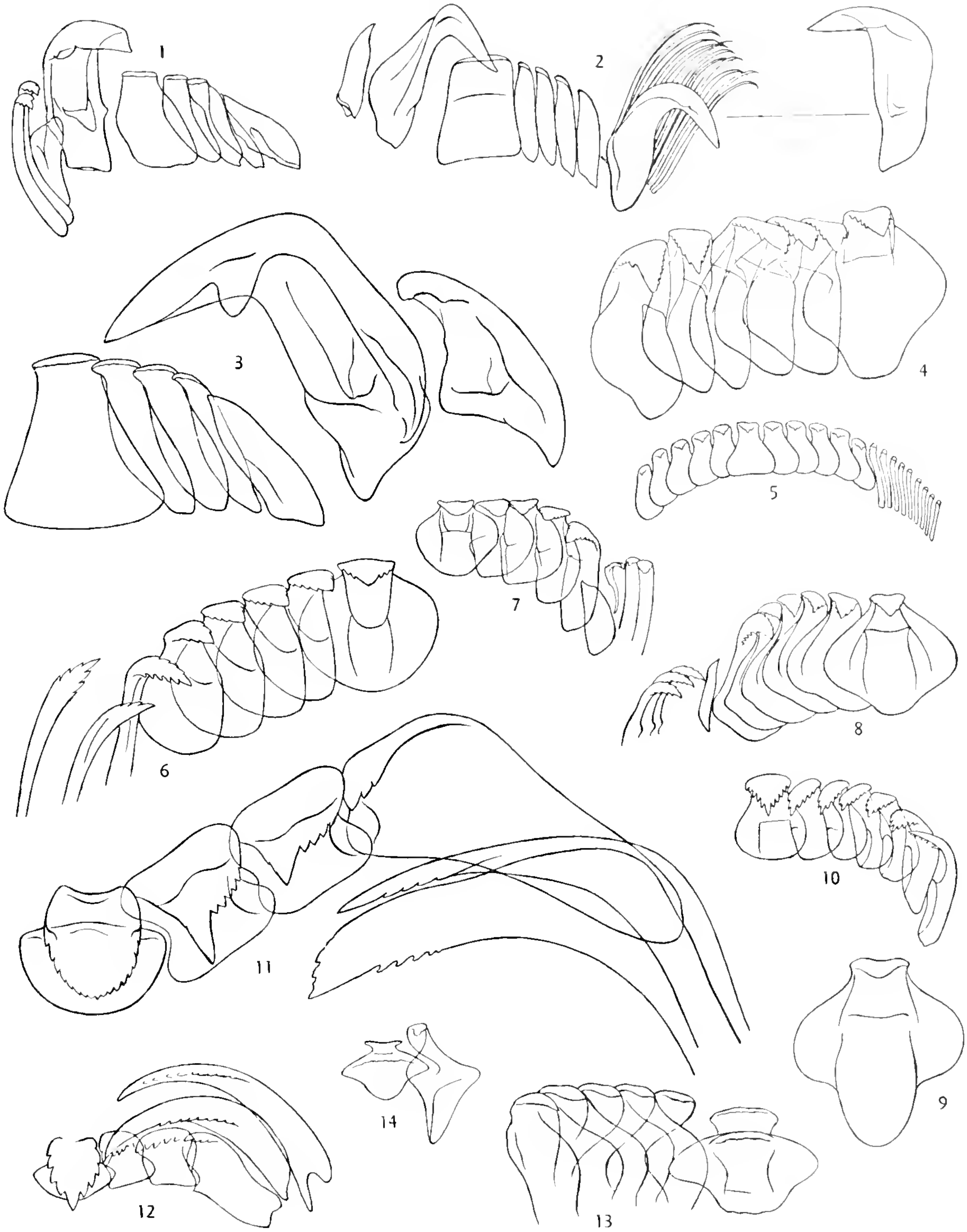

Fig. G. Dentition of Fissurellidae, Trochidae and Turbinidae. (1) *Puncturella noachina* Linn., Greenland (Troschel & Thiele, 1891, pl. 27, fig. 2). (2) *Puncturella conica* (d'Orbigny), South Georgia, St. 27. (3) *Parmaphorella melvilli* (Thiele), Falkland Is., St WS 825. (4) *Margarella (Promargarita) tropidophoroides* (Strebel), South Georgia (Thiele, 1912, pl. 15, fig. 17). (5) *Antimargarita dulcis* (Smith), McMurdo Sound (Eales, 1923, fig. 4). (6) *Tropidomarga biangulata* n.g. and n.sp., South Georgia, St. 159. (7) '*Margarita striata*' = *Pupillaria cinerea* Couthouy, Greenland (Troschel & Thiele, 1891, pl. 25, fig. 9). (8) *Margarella bouvetia* n.sp., Bouvet I. (9) *Margarella antarctica* (Lamy), South Orkneys, St. 164. (10) *Submargarita impervia* Strebel, South Georgia (Thiele, 1912, pl. 15, fig. 18). (11) *Solariella kempi* n.sp., Falkland Is., St. WS 766. (12) *Solariella biradiatula* Martens, Dar-es-Salam (Martens & Thiele, 1903, pl. 8, fig. 37). (13) *Leptocollonia thielei* n.g. and n.sp., South Georgia, St. 156. (14) *Homalopoma carpenteri* Pilsbry, California (Pilsbry, 1888, pl. 60, fig. 73).

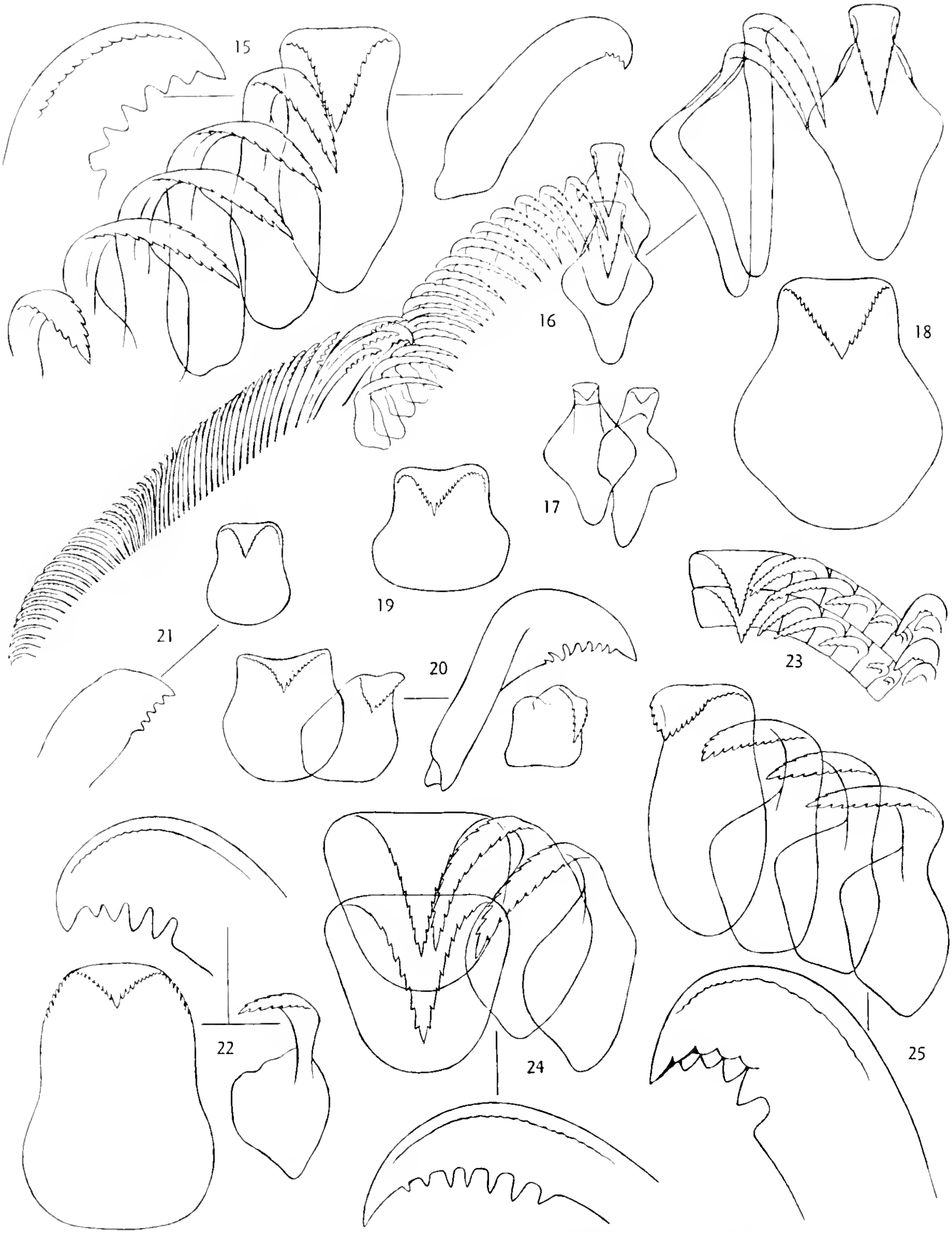

Fig. H. Dentition of Trochidae (Calliostomatinae). (15) *Calliostoma modestulum* Strebel, Falkland Is., St. WS 80. (16) *Venustatrochus georgianus* n.g. and n.sp., South Georgia, St. 42. (17) *Livonia pica* Linn., West Indies (Thiele, 1924, fig. 11). (18) *Calliostoma coppingeri* (Smith), Falkland Is., St WS. 852. (19) *Calliostoma granulatus* Born., Mediterranean (Troschel & Thiele, 1879, pl. 24, fig. 18). (20) *Calliostoma sublaevis chuni* Martens, off Somaliland (Martens & Thiele, 1903, pl. 8, fig. 42). (21) *Calliostoma conulus* Linn., Messina (Troschel & Thiele, 1879, pl. 24, fig. 16). (22) *Calliostoma nordenskjoldi* Strebel, Patagonia, St. WS. 776. (23) *Falsimargarita gemma* (Smith), off Oates Land (Eales, 1923, fig. 6). (24) *Photinula coerulescens* (King & Broderip), Falkland Is., St. WS 869. (25) *Photinastoma taeniata* (Wood), Falkland Is., St. 56.

Fig. I. Dentition of Littorinidae, Cerithiidae and Struthiolariidae. (26) *Laevilitorina caliginosa* (Gould), South Georgia St. MS 70. (27) *Laevilitorina* (*Corneolitorina*) *coriacea* Melvill & Standen, South Orkneys, St. 166. (28) *Laevilacunaria antarctica* (Martens), South Georgia (Martens & Pfeffer, 1886, pl. 3, fig. 13). (29) *Laevilacunaria* n.g. *bransfieldensis* (Preston), South Shetland Is., St. 1486. (30) *Laevilacunaria* (*Pellilacunella*) *bennetti* (Preston), Palmer Archipelago, St. 179. (31) *Macquariella aucklandica* Powell, New Zealand. (32) *Pellilitorina setosa* (Smith), South Georgia, St. MS. 71. (33) *Pellilitorina pellita* (Martens), South Orkney Is., St. 164. (34) *Ataxocerithium pullum* (Philippi), Falkland Is., St. WS. 225. (35) *Perissodonta georgiana* Strebel, South Georgia, St. WS 62. (36) *Struthiolaria papulosa* (Martyn), New Zealand. (37) *Pelicaria vermis* (Martyn), New Zealand.

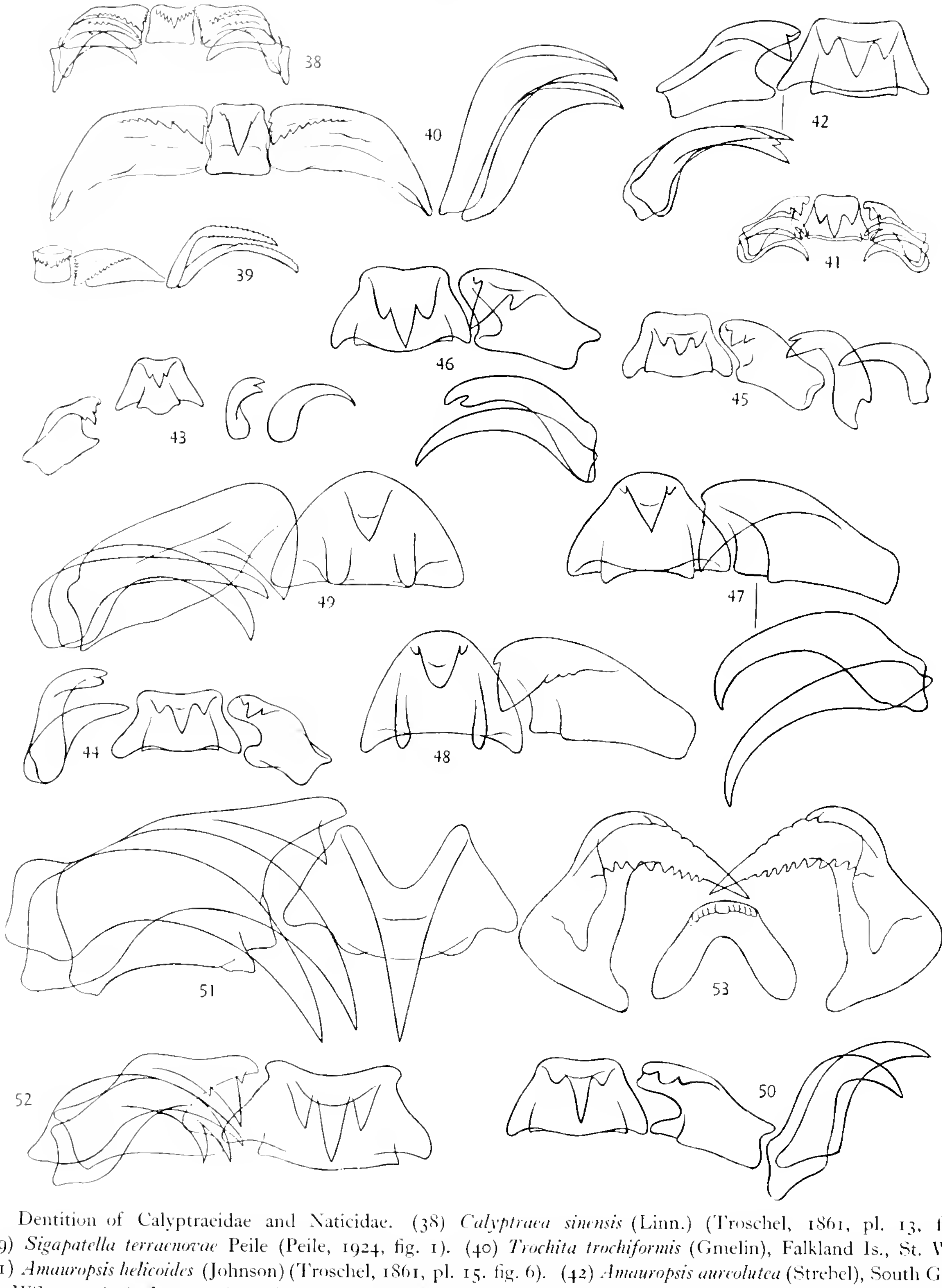

Fig. J. Dentition of Calyptraeidae and Naticidae. (38) *Calyptraea sinensis* (Linn.) (Troschel, 1861, pl. 13, fig. 7). (39) *Sigapatella terraenovae* Peile (Peile, 1924, fig. 1). (40) *Trochita trochiformis* (Gmelin), Falkland Is., St. WS 92. (41) *Amauropsis helicoides* (Johnson) (Troschel, 1861, pl. 15, fig. 6). (42) *Amauropsis aureolutea* (Strebel), South Georgia, St. WS 177. (43) *Amauropsis rossiana* Smith, McMurdo Sound (Eales, 1923, figs. 20–22). (44) *Amauropsis anderssoni* (Strebel), South Georgia, St. MS 68. (45) *Amauropsis (Kerguelenatica) grisea* (Martens), Kerguelen I. (Martens & Thiele, 1903, pl. 8, fig. 44). (46) *Tectonatica impervia* (Philippi), South Georgia, St. 159. (47) *Falsilunatia soluta* (Gould), Falkland Is., St. WS 808. (48) *Falsilunatia recognita* (Rochebrune & Mabille), Falkland Is., St. WS 766. (49) *Globisinum venustum* (Suter), New Zealand. (50) *Sinuber sculpta scotiana* n.subsp., South Orkney Is., St. 167. (51) *Tanea zelandica* (Quoy & Gaimard), New Zealand. (52) *Notocochlis migratoria* (Powell), Australia. (53) *Lamellaria* sp., Falkland Is., St. WS 867.

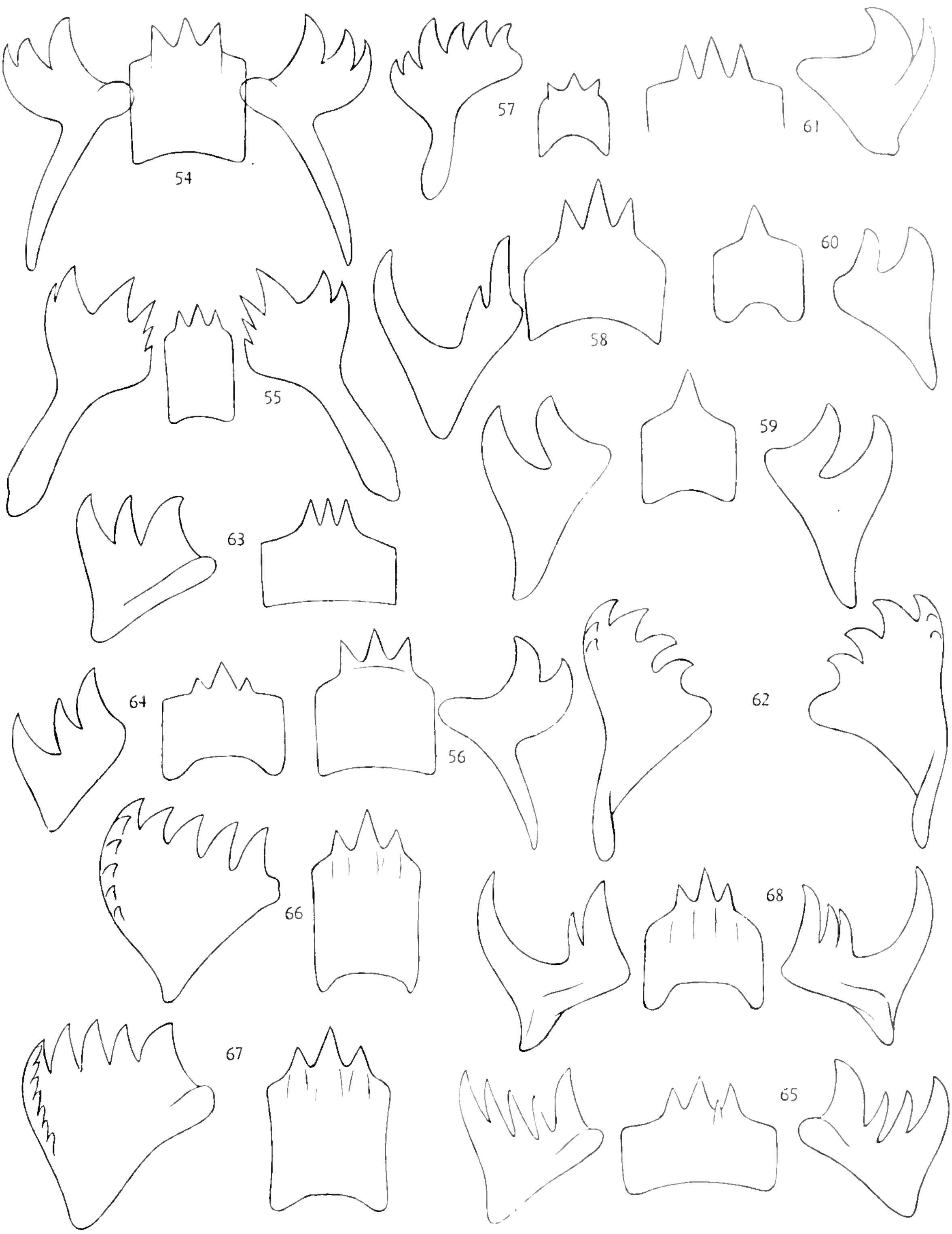

Fig. K. Dentition of Buccinacea. (54) *Prosipho madigani* Hedley, Palmer Archipelago, St. 182. (55) *Prosipho chordatus* (Strebel), South Georgia, St. 123. (56) *Prosipho astrolabiensis* (Strebel), South Georgia, St. 140. (57) *Anomacme smithi* Strebel (Thiele, 1912, pl. 16, fig. 14). (58) *Glypteuthria meridionalis* (Smith) (Thiele, 1912, pl. 16, fig. 17). (59) *Falsimohnia albozonata* (Watson), South Georgia, St. 140. (60) *Lachesis australis* Martens = *F. albozonata* Martens & Thiele, Kerguelen I. (Martens & Thiele, 1903, pl. 9, fig. 55). (61) *Notoficula problematica* n.sp., Falkland Is., St. WS 766. (62) *Meteuthria martensi* (Strebel) (Thiele, 1912, pl. 16, fig. 18). (63) *Probuccinum delicatulum* n.sp., South Georgia, St. 140. (64) *Probuccinum 'tenerum'* Thiele (Thiele, 1912, pl. 16, fig. 21). (65) *Probuccinum angulatum* n.sp., South Georgia, St. 156. (66) *Proneptunea duplicarinata* n.sp., South Georgia, St. 160. (67) *Proneptunea fenestrata* n.sp., South Georgia, St. 141 (68) *Cavineptunea monstrosa* n.g. and n.sp., South Georgia, St. 159.

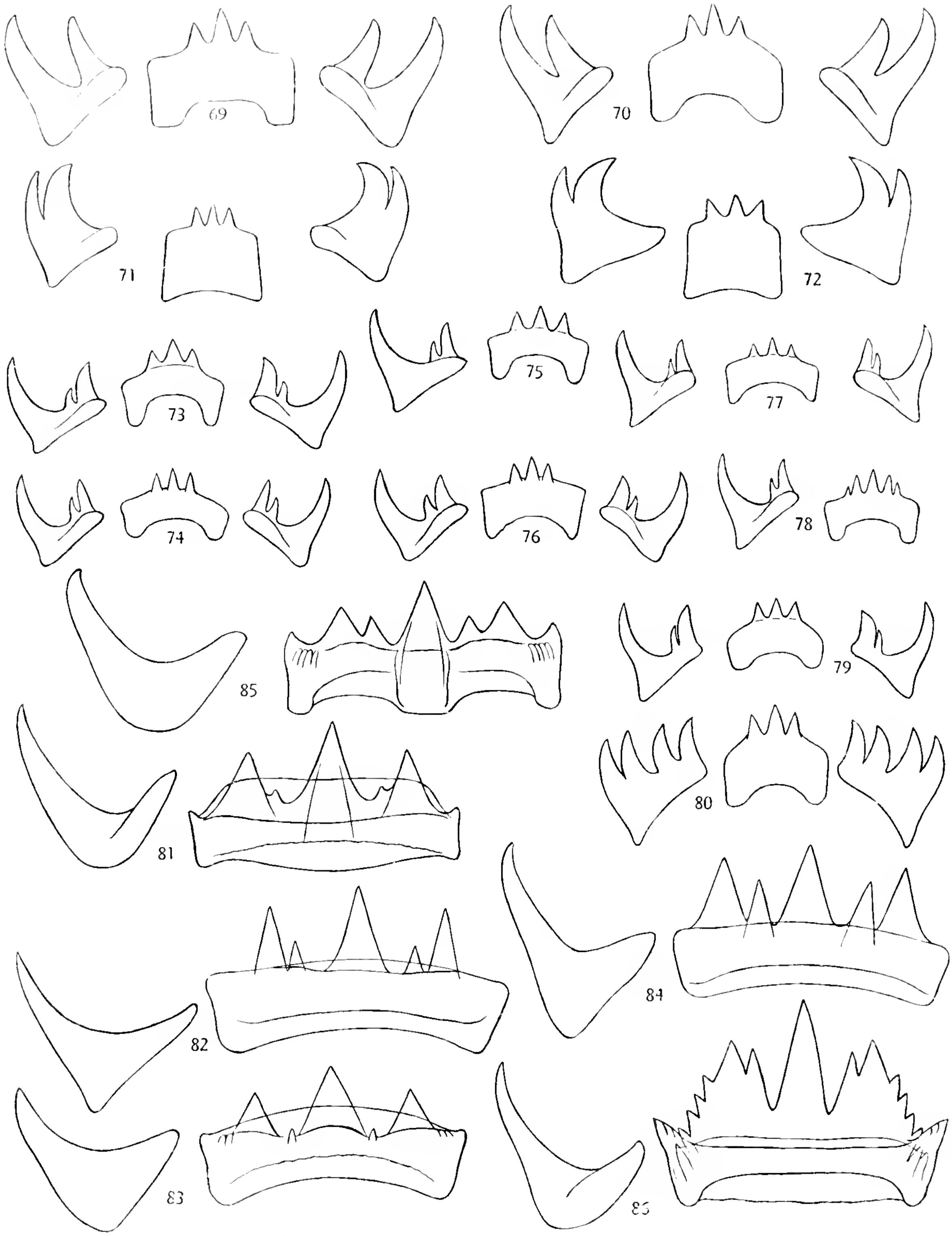

Fig. L. Dentition of Buccinacea and Muricidae. (69) *Pareuthria fuscata* (Brug.), Falkland Is., St. 56. (70) *Pareuthria venustula* n.sp., Cape Horn—Staten I., St. 388. (71) *Tromina tricarinata* n.sp., Clarence I., St. 170. (72) *Tromina bella* n.sp., Falkland Is., St. WS 818. (73) *Chlanidota pilosa* n.sp., Bouvet I., St. 456. (74) *Chlanidota signeyana* n.sp., South Orkney Is., St. 167. (75) *Chlanidota densesculpta* (Martens), South Georgia, St. MS 10. (76) *Chlanidota elongata* (Lamy), South Shetland Is., St. 1952. (77) *Chlanidota paucispiralis* n.sp., South Georgia, St. 159. (78) *Pfefferia elata* Strebel, South Georgia, St. 30. (79) *Pfefferia cingulata* Strebel, South Georgia, St. 146. (80) *Chlanidotella modesta* (Martens), South Georgia, St. MS. 10. (81) *Trophon geversianus* (Pallas), off Patagonia, St. WS 847. (82) *Trophon shackletoni paucilamellatus* n.subsp., South Georgia, St. 144. (83) *Trophon echinolamellatus* n.sp., Clarence I., St. 170. (84) *Trophon ohlini* Strebel, Falkland Is., St. WS 80. (85) *Trophon (Fuegotrophon) pallidus* (Brod.), Falkland Is., St. 56. (86) *Trophon (Stramonitrophon) laciniatus* (Martyn), Falkland Is., St. WS 788.

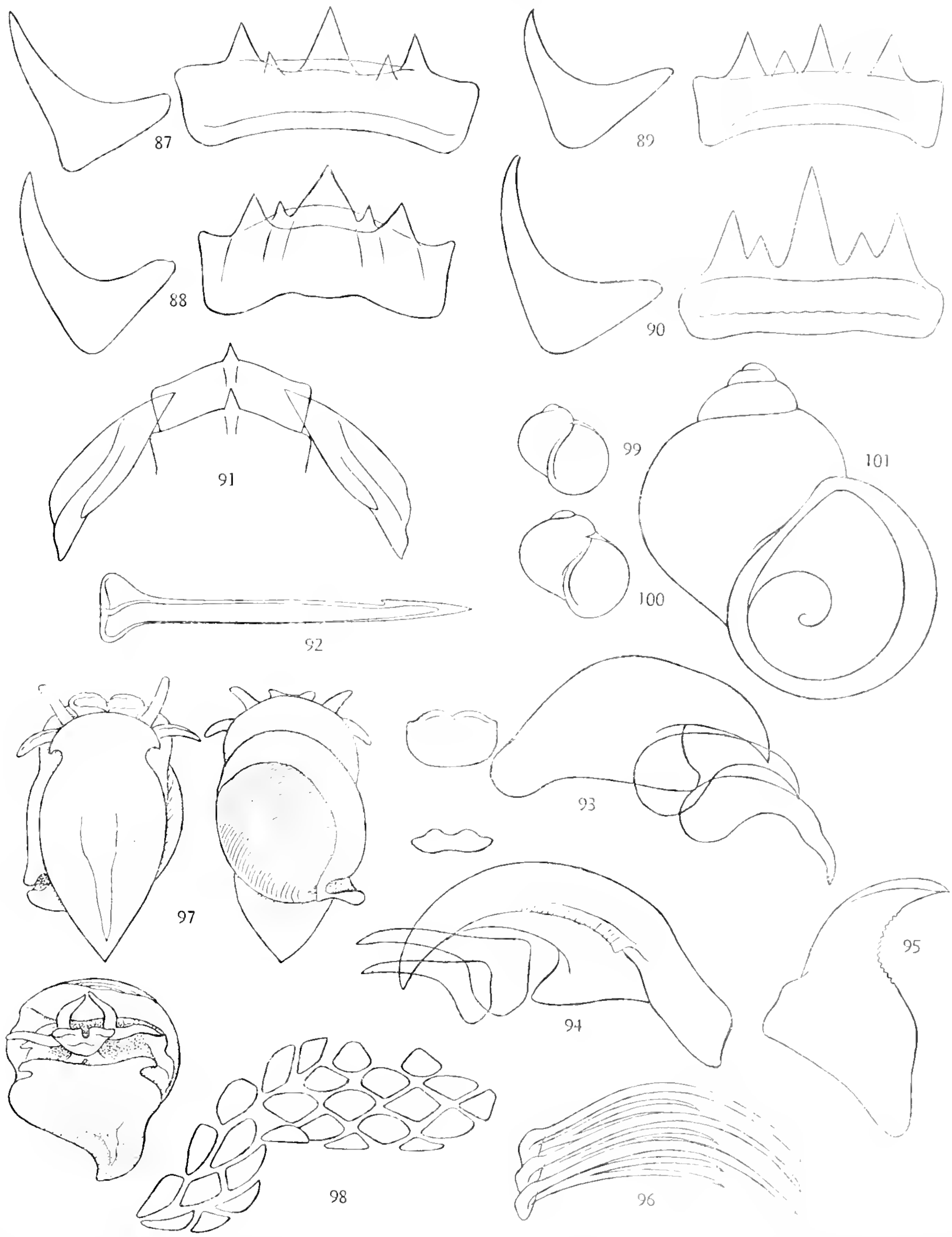

Fig. M. Dentition of Muricidae, Turridae and Tectibranchia. (87) *Trophon distantelamellatus* Strebel, South Georgia, St. MS 67. (88) *Trophon scotianus* n.sp., South Georgia, St. WS 27. (89) *Trophon cuspidarioides* n.sp., South Georgia, St. 42 (90) *Xymenopsis albidus* (Philippi), off Patagonia, St. WS 834. (91) *Aforia magnifica* (Strebel), Palmer Archipelago, St. 182. (92) *Typhlodaphne purissima* (Strebel), South Georgia, St. 159. (93) *Kaitoa scaphandroides* n.sp., South Georgia, St. 30. (94) *Philine falklandica* n.sp., Falkland Is., St. WS 225. (95) *Philine* cf. *kerguelensis* Thiele, Falkland Is., St. WS 219. (96) *Parvaplustrum tenerum* n.sp., Falkland Is., St. WS 219. (97) *Parvaplustrum tenerum* n.sp., ventral, dorsal and frontal views. (98) *Parvaplustrum tenerum* n.sp., stomach plates. (99) *Laevilacunaria (Pellilacunaria) bennetti* (Preston). Tracing of Preston's figure of holotype (2 × 2 mm.). (100) *Laevilacunaria bennetti*, juvenile (2 × 2 mm.). (101) *Laevilacunaria bennetti*, adult (6 × 5 mm.). Palmer Archipelago, St. 179.

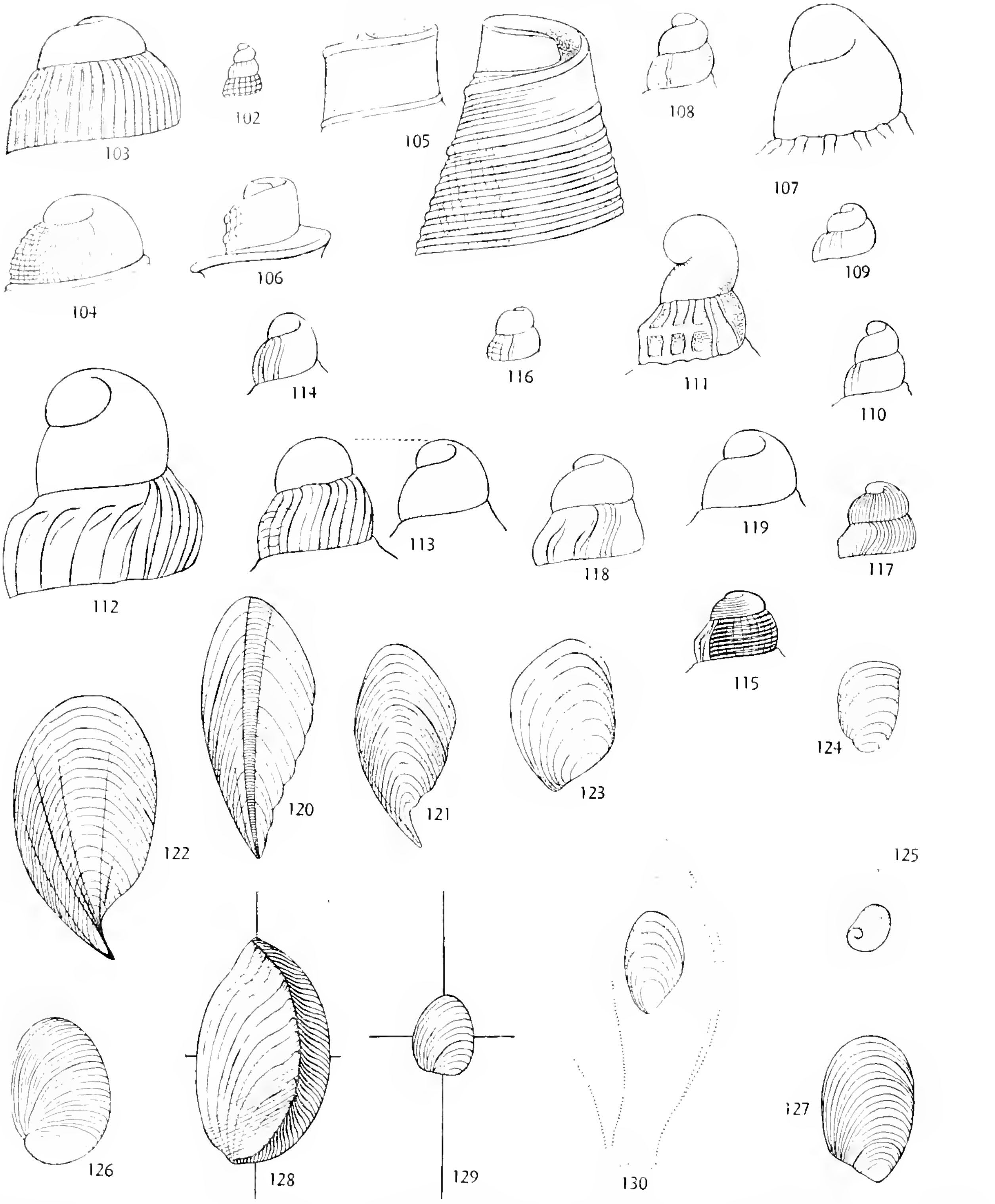

Fig. N. Protoconchs (all to uniform scale). (102) *Ataxocerithium pullum* (Philippi), Falkland Is., St. WS 225. (103) *Tromina tricarinata* n.sp., Clarence I., St. 170. (104) *Tromina bella* n.sp., Falkland Is., St. WS 817. (105) *Cavineptunea monstrosa* n.g. and n.sp., South Georgia, St. 159. (106) *Proneptunea fenestrata* n.sp., South Georgia, St. 140. (107) *Trophon geversianus* (Pallas), Falkland Is. (108) *Zeatrophon ambiguus* (Philippi), New Zealand. (109) *Xymene plebejus* (Hutton), New Zealand. (110) *Xymenopsis liratus* (Gould), Falkland Is., St. 52. (111) *Trophon* (*Fuegotrophon*) *pallidus* (Broderip), Staten I., St. WS 88. (112) *Leucosyrinx falklandica* n.sp., Falkland Is., St. WS 781. (113) *Leucosyrinx paragenota* n.sp., Burdwood Bank, St. 652. (114) *Lorabela* n.g. *notophila* (Strebel), South Georgia, St. WS 27. (115) *Belalora thielei* n.g. and n.sp., Falkland Is., St. WS 801. (116) *Pleurotomella? ohlini* (Strebel), Falkland Is. (117) *Pleurotomella simillima* (Thiele), Ross Sea, St. 1660. (118) *Eumetadrillia fuegiensis* (Smith), off Patagonia, St. WS 787. (119) *Typhlodaphne* n.g. *purissima* (Strebel), South Georgia, St. 159. Opercula (Figs. 120, 121, 123–126, 130 all to uniform scale. Fig. 122 = ⅔, and Fig. 127 = × 2). (120) *Perissodonta georgiana* Strebel, South Georgia, St. WS 62. (121) *Pelicaria vermis* (Martyn), New Zealand. (122) *Struthiolaria papulosa* (Martyn), New Zealand. (123) *Probuccinum delicatulum* n.sp., South Georgia, St. 159. (124) *Proneptunea fenestrata* n.sp., South Georgia, St. 140. (125) *Notoficula problematica* n.sp., Falkland Is., St. WS 766. (126) *Tromina tricarinata* n.sp., Clarence I., St. 170. (127) *Falsimohnia albozonata* (Watson), South Georgia, St. 149. (128) *Pfefferia elata* Strebel, South Georgia. (129) *Chlanidota signeyana* n.sp., South Orkney Is. (size relationship between operculum and aperture represented by crossed lines). (130) *Typhlodaphne* n.g. *purissima* (Strebel), South Georgia, St. 159.

PLATE V

Fig. 1. *Margarella jason* n.sp., 6 × 4·5 mm. (holotype), St. 45, South Georgia, 238–270 m.

Fig. 2. *Margarella porcellana* n.sp., 8 × 7 mm. (holotype), St. 1562, off Marion I., 97–104 m.

Fig. 3. *Margarella bouvetia* n.sp., 8·4 × 7·5 mm. (holotype), St. 456, off Bouvet I., 40–45 m.

Fig. 4. *Margarella* (*Promargarita*) *tropidophoroides obsoleta* n.subsp., 13·5 × 11 mm. (holotype), St. MS 6, South Georgia, 24–30 m.

Fig. 5. *Tropidomarga biangulata* n.g. and n.sp., 14·6 × 13 mm. (holotype), St. 159, South Georgia, 160 m.

Fig. 6. *Solariella kempi* n.sp., 12 × 11·75 mm. (holotype), St. WS 766, between Falkland Is. and Argentina, 545 m.

Fig. 7. *Brookula strebeli* n.sp., 1·5 × 1·25 mm. (holotype), St. 144, South Georgia, 155–178 m.

Fig. 8. *Brookula pfefferi* n.sp., 2 × 1·75 mm. (holotype), St. 144, South Georgia, 155–178 m.

Fig. 9. *Leptocollonia thielei* n.sp., 9 × 7·5 mm. (holotype), St. 153, South Georgia, 106 m.

Fig. 10. *Sinuber sculpta scotiana* n.subsp., 9·5 × 8 mm. (holotype), St. 167, South Orkney Is., 244–344 m.

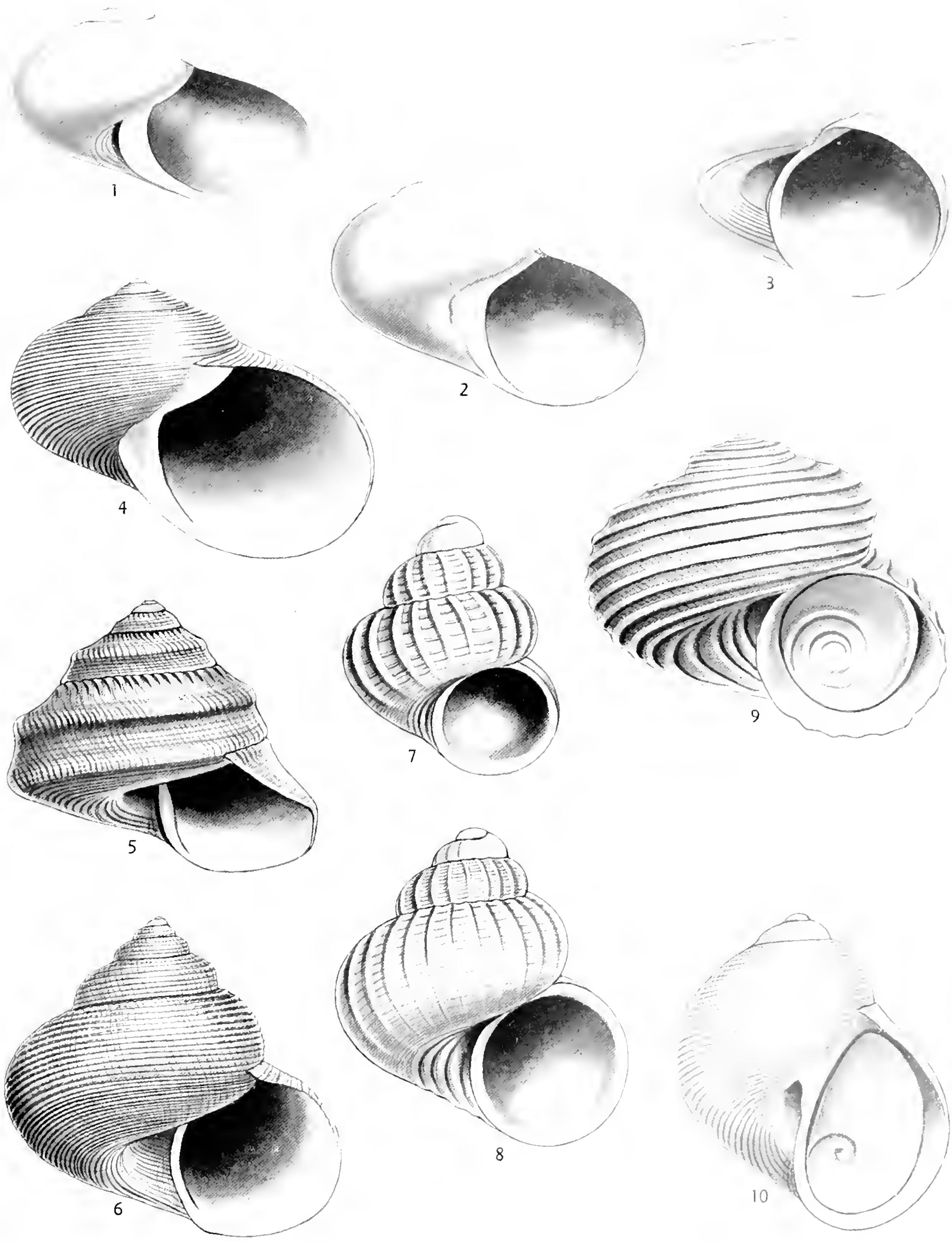
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PLATE VI

Fig. 11. *Prosipho perversus* n.sp., 4 × 2 mm. (holotype), St. 144, South Georgia, 155–178 m.

Fig. 12. *Proneptunea fenestrata* n.sp., 12 × 6·6 mm. (holotype), St. 141, South Georgia, 17–27 m.

Fig. 13. *Proneptunea duplicarinata* n.sp., 17 × 7 mm. (holotype), St. 160, between South Georgia and Shag Rocks, 177 m.

Fig. 14. *Tromina fenestrata* n.sp., 6 × 4 mm. (holotype), St. WS 766, between Falkland Is. and Argentina, 545 m.

Fig. 15. *Tromina simplex* n.sp., 7·25 × 4·25 mm. (holotype), St. WS 237, north of Falkland Is., 150–256 m.

Fig. 16. *Tromina bella* n.sp., 7·4 × 5 mm. (holotype), St. WS 817, between Falkland Is. and Patagonia, 191–202 m.

Fig. 17. *Pareuthria venustula* n.sp., 13·3 × 5·9 mm. (holotype), St. 388, between Cape Horn and Staten I., 121 m.

Fig. 18. *Notoficula problematica* n.sp., 5·25 × 3·6 mm. (holotype), St. WS 766, between Falkland Is. and Argentina, 545 m.

Fig. 19. *Pleurotomella? anomalapex* n.sp., 7·8 × 3·9 mm. (holotype), St. WS 225, between Falkland Is. and Patagonia, 162–161 m.

Fig. 20. *Belalora thielei*, n.g. and n.sp., 7·1 × 3·7 mm. (holotype), St. WS 801, north-west of Falkland Is. to Patagonia, 165 m.

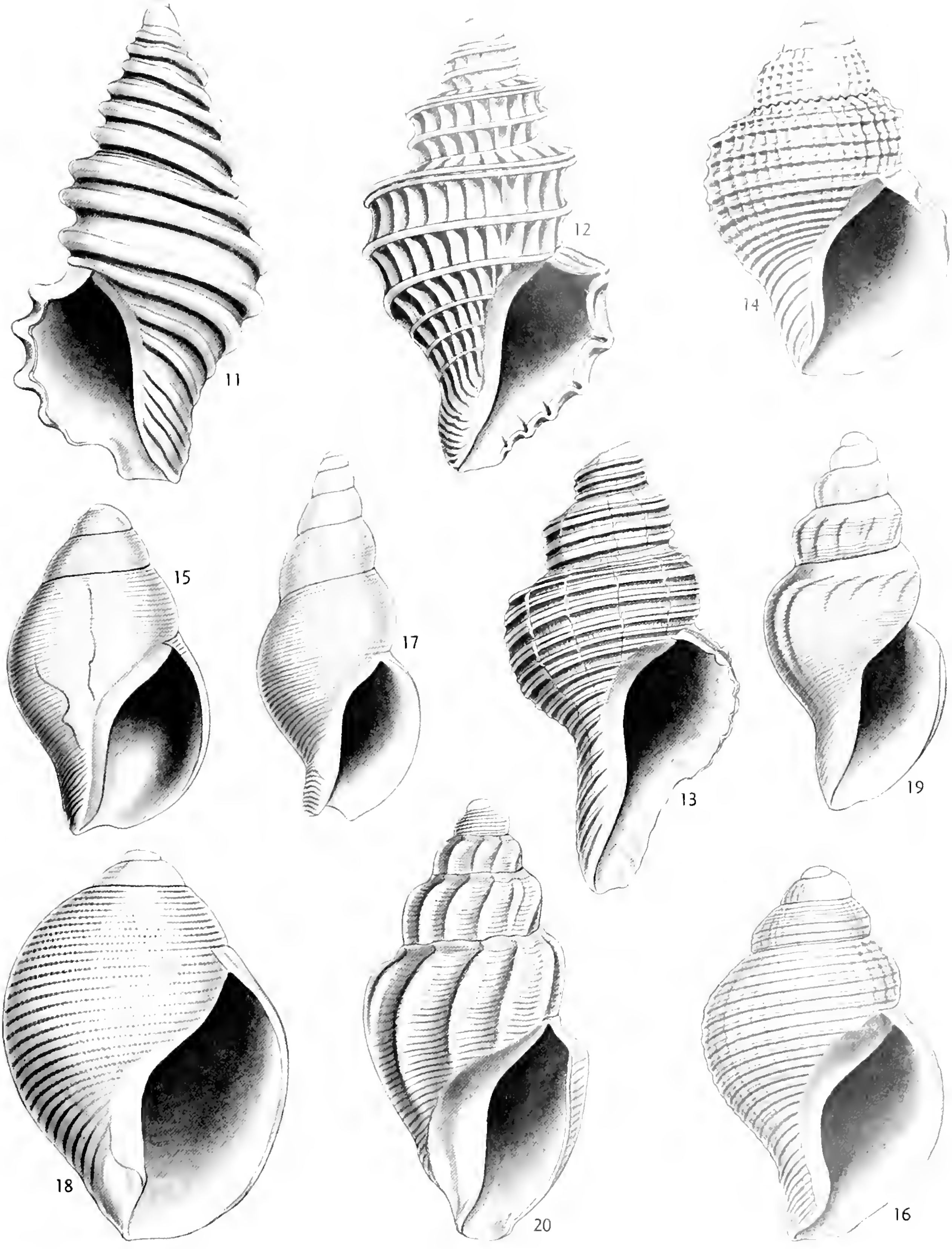
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PLATE VII

Fig. 21. *Discotrichoconcha cornea* n.g. and n.sp., 5·3 × 1·7 mm. (holotype), St. 182, Palmer Archipelago, 278–500 m.

Fig. 22. *Trochita georgiana* n.sp., 12·5 × 7·5 mm. (holotype), St. 160, near Shag Rocks, west of South Georgia, 177 m.

Fig. 23. *Acirsa annectens* n.sp., 11·5 × 4·5 mm. (holotype), St. WS 766, north of Falkland Is., 545 m.

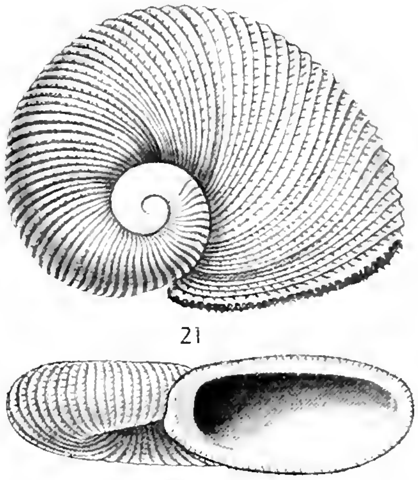
Fig. 24. *Philine falklandica* n.sp., 4·9 × 3·9 mm. (holotype), St. WS 219, between Falkland Is. and Patagonia, 116 m.

Fig. 25. *Parvaplustrum tenerum* n.g. and n.sp., 2·8 × 2·15 mm. (holotype), St. WS 219, between Falkland Is and Patagonia, 116–114.

Fig. 26. *Turritellopsis thielei* n.sp., 8·5 × 3·8 mm. (holotype), St. 181, Palmer Archipelago, 160–335 m.

Fig. 27. *Probuccinum angulatum* n.sp., 9·9 × 7 mm. (holotype), St. 156, north of South Georgia, 200–236 m.

Fig. 28. *Probuccinum delicatulum* n.sp., 20·5 × 10·5 mm. (holotype), St. 140, South Georgia, 122–136 m.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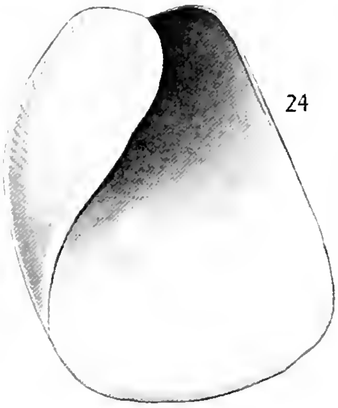
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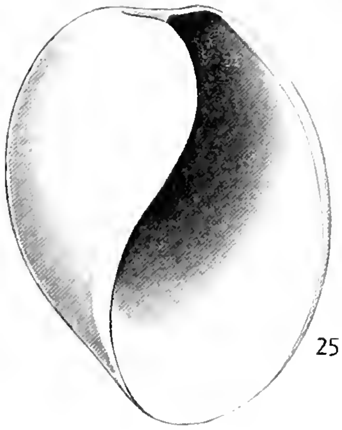
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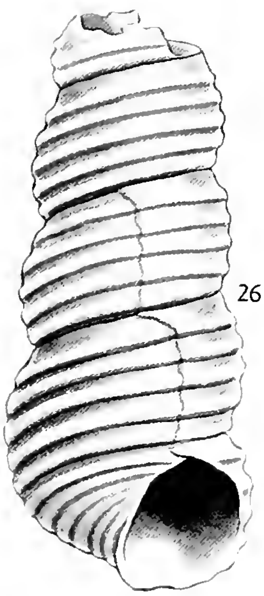
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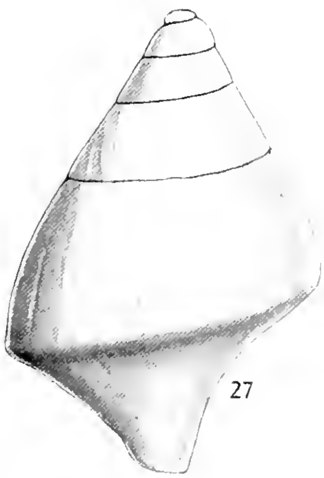
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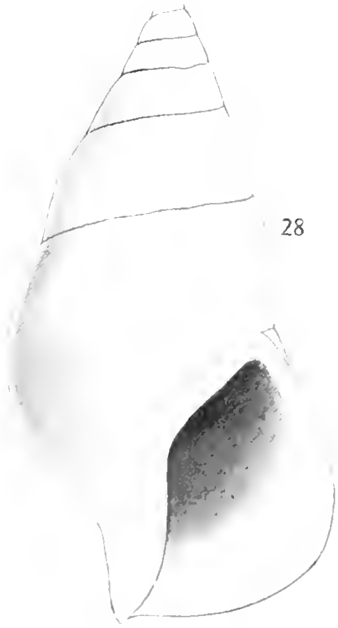
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PLATE VIII

Figs. 29, 30. *Chlanidota pilosa* n.sp., 25·5 × 20 mm. (holotype), St. 456, 1 mile east of Bouvet I., 40–45 m.

Fig. 31. *Chlanidota densesculpta* (Martens, 1885), 30 × 21 mm., St. 1941, South Georgia, 55–22 m.

Fig. 32. *Chlanidota densesculpta* (Martens, 1885), 30 × 18 mm., St. WS 62, South Georgia, 26–83 m.

Fig. 33. *Chlanidota densesculpta* (Martens, 1885), 40 × 23 mm., St. WS 62, South Georgia, 26–83 m.

Fig. 34. *Chlanidota signeyana* n.sp., 38 × 24·5 mm. (holotype), St. 167, Signy I., South Orkney Is., 244–344 m.

Fig. 35. *Chlanidota signeyana* n.sp., St. 167 (paratype).

Fig. 36. *Chlanidota paucispiralis* n.sp., 22·1 × 13·5 mm. (holotype), St. 159, South Georgia, 160 m.

Fig. 37. *Chlanidota paucispiralis* n.sp., St. 159 (paratype).

Figs. 38, 39. *Cavineptunea monstrosa* n.g. and n.sp., 36 × 18 mm. (holotype), St. 159, South Georgia, 160 m.

Figs. 40–42. *Perissodonta georgiana* Strebel, 1908, St. WS 62, South Georgia, 130 m.

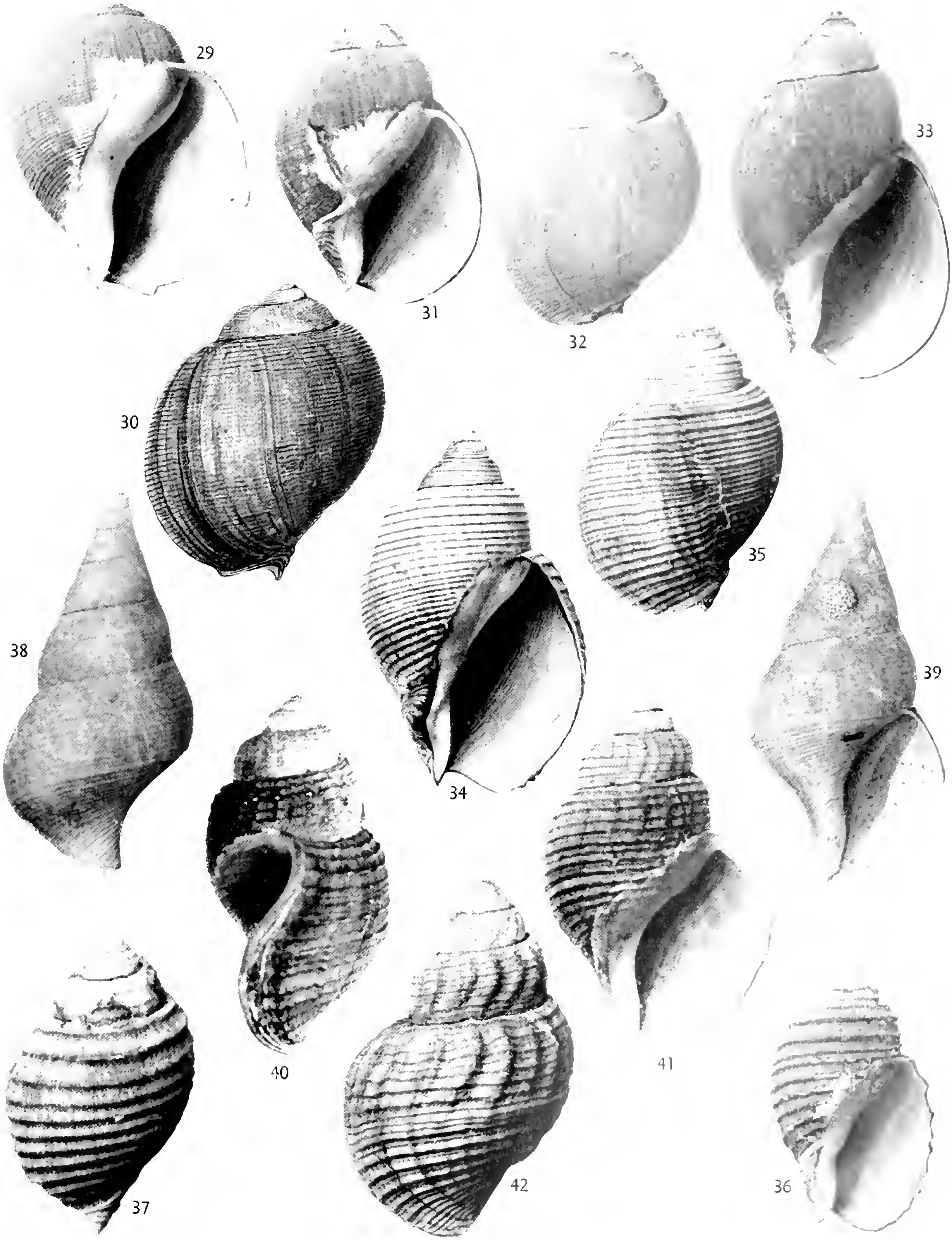
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PLATE IX

Fig. 43. *Miomelon scoresbyana* n.sp., 48·4 × 25·5 mm. (holotype), St. WS 816, between Falkland Is. and Strait of Magellan, 150 m.

Fig. 44. *Trophon echinolamellatus* n.sp., 64 × 39 mm. (paratype), St. 170, Clarence I., 342 m.

Fig. 45. *Trophon echinolamellatus* n.sp., 63 × 35 mm. (holotype), St. 170, Clarence I., 342 m.

Figs. 46, 47. *Xymenopsis falklandicus* (Strebel, 1908) (n.g.), St. 55, Port Stanley, Falkland Is., 10–16 m.

Figs. 48, 49. *Trophon scotianus* n.sp., 34 × 24 mm. (holotype), St. WS 27, South Georgia, 107 m.

Fig. 50. *Trophon cuspidarioides* n.sp., 13 × 5·7 mm. (holotype), St. 42, South Georgia, 120–204 m.

Fig. 51. *Trophon poirieria* n.sp., 15·5 × 8·75 mm. (holotype), St. 190, Palmer Archipelago, 93–130 m.

Fig. 52. *Trophon shackletoni paucilamellatus* n.subsp., 31 × 21 mm. (holotype), St. 148, South Georgia, 132–148 m.

Fig. 53. *Typhlodaphne strebeli* n.sp., 20 × 7·25 mm. (holotype), St. 388, between Cape Horn and Staten I., 121 m.

Fig. 54. *Leucosyrinx paratenoceras* n.sp., 38·75 × 11·5 mm. (holotype), St. 1952, South Shetland Is., 367–382 m.

Fig. 55. *Leucosyrinx falklandica* n.sp., 15·75 × 5·8 mm. (holotype), St. WS 781, north of Falkland Is., 336–341 m.

Fig. 56. *Leucosyrinx paragenota* n.sp., 21·25 × 7·5 mm. (holotype), St. 652, Burdwood Bank, 171–169 m.

Fig. 57. *Paradmete percarinata* n.sp., 16·5 × 10·5 mm. (holotype), St. 1957, Clarence I., South Shetland Is., 785–810 m.

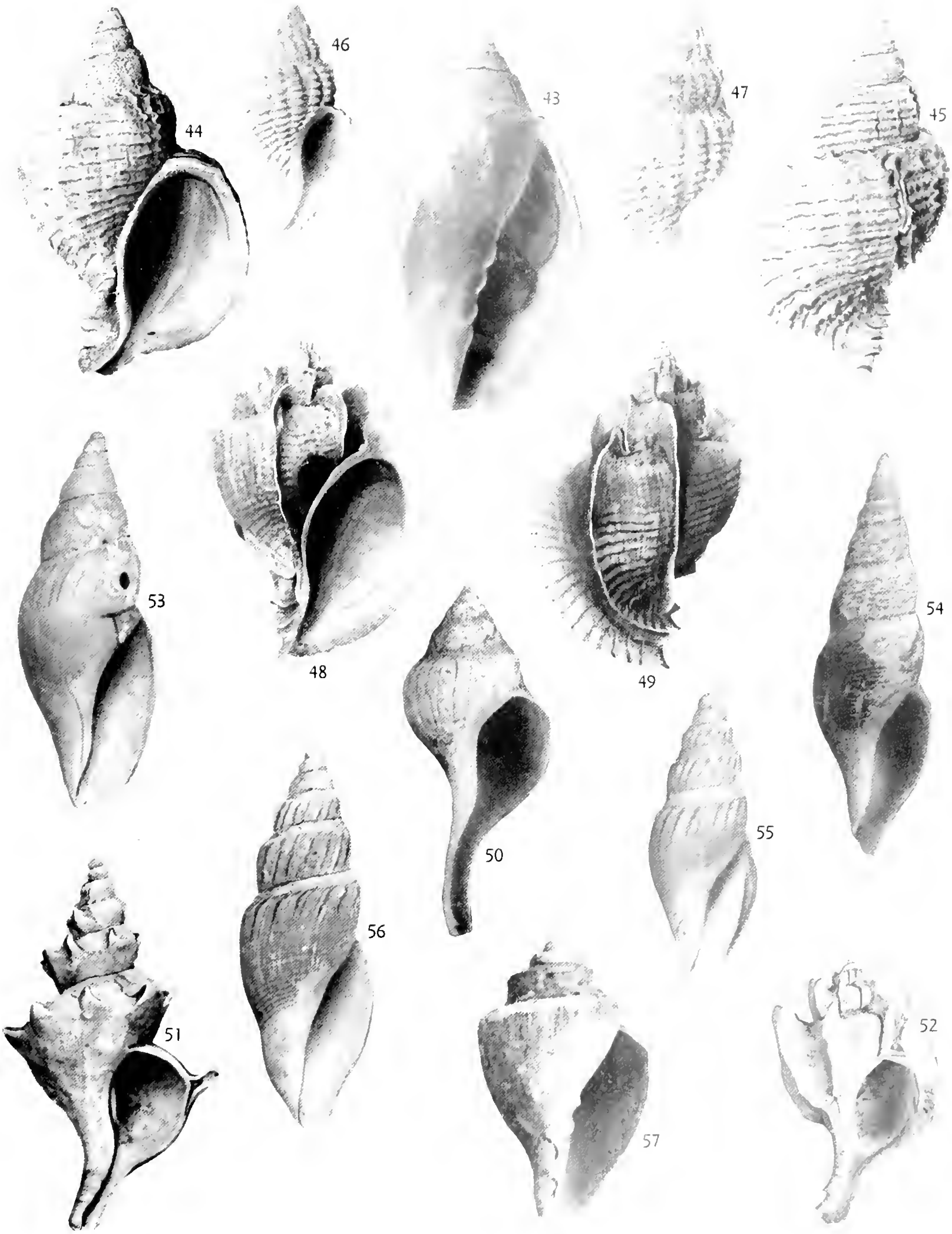
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PLATE X

Figs. 58, 59. *Amauropsis anderssoni* (Strebel, 1907), St. WS 62. Wilson Harbour, South Georgia, 26–83 m.

Fig. 60. *Amauropsis* (*Kerguelenatica*) *grisea* (Martens, 1878) (n.subg.), Royal Sound, Kerguelen I. (British Museum).

Fig. 61. *Falsilunatia falklandica* (Preston, 1913) (n.g.) Port Stanley, Falkland Is. (paratype, British Museum).

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THE VAMPYROMORPHA OF THE DISCOVERY EXPEDITIONS

By

GRACE E. PICKFORD

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THE VAMPYROMORPHA OF THE DISCOVERY EXPEDITIONS

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(Text-figs. 1–4)

INTRODUCTION

During the years 1927 to 1937 the ships of the Discovery Committee captured nine specimens of the octopod, *Vampyroteuthis infernalis* Chun. This material contributes towards our knowledge of vampyromorph morphology, throws new light on the geographical range of the species, and tends to confirm previous findings with regard to vertical distribution and hydrographical correlations. A survey of previous investigations is contained in the following papers, Pickford (1946, 1949*a*, 1949*b*, 1950).

I am indebted to the National Institute of Oceanography (which has taken over the work of the Discovery Committee) for permission to examine these interesting specimens, and to Dr W. J. Rees for working facilities at the British Museum during the summer of 1951.

MORPHOLOGICAL CHARACTERS

Colour. In four cases the original colour of the specimen has been entered on the label. Specimen No. 99: 'Deep purple'; specimen No. 101: 'General tendency dark almost inky purple. Pale translucent purple where epidermis rubbed off'; specimen No. 102: 'Epidermis very deep inky purple, almost black. Translucent pale purple where skin stripped off'; and specimen No. 103: 'Intense deep purple'.

These observations are unexpected and interesting. The present colour of the external surface is black, as it is in all preserved specimens that are not totally faded as the result of prolonged storage in neutral formalin. The purple colour is evidently due to an unstable pigment that fades in preserving fluids. However, two points are worth noting. The formalin preserved specimens of the Bingham Oceanographic Collection retained a good deal of pink or red colour that could be seen on the suckers, the cirri, and the inside of the mantle where black and brown chromatophores are not present. Unpublished results of histological study show that this pigment is located in the epithelial cells, and not in chromatophores. In preserved specimens it is so faded as to be masked by underlying black or brown chromatophores in the subcutaneous tissues. One must suppose that in life an intense red or purple pigment in the epidermal cells would impart a purple tinge even to an otherwise black background. The writer has only seen freshly captured *Vampyroteuthis* on two occasions, while with the Danish 'Galathea' Deep Sea Expedition in 1951 in the Bay of Bengal. Unfortunately these specimens were badly rubbed and damaged; such colour as remained was black, but this may well have been due to destruction of the epidermis.

A further problem concerns the natural colour of the oral face of the web. The original coloured picture (Thiele, 1914) shows it as brown, and this colour has been repeatedly observed by the writer in formalin preserved specimens whenever they were not completely faded by the addition of borax for neutralization. A red-brown web was observed, for example, in the formalin preserved specimens

of the Bingham Oceanographic Collection, and a check on the Bermuda series (Pickford, 1950) shows that here also the oral face is brown. It was therefore a surprise to find that the oral face of the web is black in the nine Discovery specimens which are preserved in alcohol. Presumably in life it may even have been purple. An exactly similar observation was made on the Indian Ocean specimens taken by the 'Galathea'. Five of the Discovery specimens are from the Atlantic Ocean and we may therefore exclude the possibility of zoogeographical differences.

Table 1. *List of specimens, dates of capture and summary of distribution*

Spec. No.*	Stn	Date	Latitude	Longitude	Ocean basin†
96	269	26. vii. 1927	15° 55′ 00″ S	10° 35′ 00″ E	Angola basin
97	287	19. viii. 1927	02° 49′ 30″ S	09° 25′ 30″ W	Guinea basin
98	1587	3. v. 1935	06° 05′ N	52° 00″ E	Somali basin
99	1739	17. iv. 1936	32° 05·9′ S	105° 23′ E	Junction of Indo-Australian and South Australian basin
100	1764	6. v. 1936	32° 00′·8 S	36° 26·7′ E	Eastern extension of Agulhas basin in S. Indian ocean
101	2059	30. iv. 1937	09° 11·4′ S	05° 17·4′ W	Between Guinea and Angola basins
102	2061	1. v. 1937	06° 36′ S	06° 25·1′ W	Guinea basin
103	2065	4. v. 1937	02° 11·8′ S	06° 55·7′ W	Guinea basin
104	2080	29. x. 1937	10° 12·7′ S	04° 02′ W	Between Guinea and Angola basins

* Author's register of known specimens. Nos. 1–77 are listed in the Dana Reports (Pickford, 1946, 1949*a*), Nos. 78–95 in *The Vampyromorpha of the Bermuda Oceanographic Expeditions* (Pickford, 1950).

† Designations of basins from Sverdrup, Johnson & Fleming (1942).

Unpublished histological studies on the pigment cells of *Vampyroteuthis* have shown that the black pigment is in the form of rather large, spherical granules whereas the red-brown pigment is in the form of much smaller and more irregular granules that tend to clump in little aggregations, giving an appearance of reticulation to the chromatophore. Clearly there are physical if not chemical differences between the black and 'brown' chromatophores but it is possible that the latter only assume their brown colour after certain methods of preservation. We cannot escape from the fact that in life, and in alcohol preserved specimens of the Discovery collections, the oral face of the web is black.

Mantle length. The observed mantle length of the specimens is given in Table 2, except for specimen No. 96 which was too badly damaged for measurement. The larva of *Vampyroteuthis* goes through a complicated double metamorphosis in which the posterior or larval fin reaches a length of about 5 mm. and is then resorbed, while an anterior (adult) fin develops in smoothly co-ordinated functional adjustment (Pickford, 1949*a*). The developmental stages are defined in terms of the presence or absence and relative lengths of the two pairs of fins. It has further been shown that each developmental stage is associated with a characteristic range of mantle length. But the mantle length of several of the Discovery specimens appears to be in poor agreement with the developmental fin stage. An attempt has therefore been made to deduce a corrected estimate of mantle length from measurements of the eye diameter and of anterior fin length. The estimates are based on a previous investigation of the relationships between mantle length and other bodily proportions, given in the article cited above. These estimates of corrected mantle length are given in Table 3. It will be seen that, in general, the estimates are in good agreement with actual observation. However, specimen No. 101,

which appears to be badly shrunken, is shown to have had a probable mantle length of 20–21 mm. instead of 14 mm. On the other hand specimen No. 103, in which the subcutaneous gelatinous tissues are clearly abnormally swollen, appears to have had a true mantle length of about 26 mm. as compared with the observed value of 30 mm. In both these animals the corrected values are in better agreement with the fin stage than the observed values. The posterior fin of specimen No. 101 is in poor condition and was certainly longer than the 2·5 mm. recorded in Table 2; we may assume that

Table 2. *Morphological characters*

(Measurements in mm.)

Spec. No.	Sex	Mantle length	Eye diam.	Anterior fin length	Posterior fin length	Stage	Comments
96	♂	?	6·0	15·5*	Not vis.	?4	Left eye gone, mantle everted and badly distorted
97	?	10·5	2·9*	?	*c.* 2+*	?2	Mantle rubbed, fins poor
98	♂	28	6·0	12	0·6	4	
99	♀	47	16·5*	29*	Resorbed	5	Surface rubbed, right eye damaged
100	?♀	*c.* 10+	2·4	1·0	3·2	2	Condition very perfect, but mantle sac is everted
101	♀	14+	5·0	5·0	2·5+	?3	Rather shrunken
102	♂	25	6·5*	8·0	4·5	4	Skin rubbed
103	♂	30	*c.* 8* (through tissues)	14	Minute rudiment	4–5	Gelatinous tissues very swollen; right eye protrudes
104	♂	29	9·5	10·0	Minute rudiment	4–5	Skin rubbed

* Left side in better preservation and measured instead of right.

Table 3. *Estimates of true mantle length*

Spec. No.	Observed ML	Estimated from ED*	Estimated from FaL†
96	?	24·5	27
97	10·5	13	—
98	28	24·5	25·5
99	47	41	54
100	10+	12	14
101	14+	21	20·5
102	25	26	23
103	30	25	26·5
104	29	28	24·5

* The relationship between eye diameter (ED) and mantle length (ML) has been analysed by Pickford (1949*a*, pp. 75–6). The curve for adults was used for specimen No. 99, the curve for all stages was used for the two stage 4–5 specimens (Nos. 103 and 104), and the rest were taken from the curve for larvae.

† The relationships between anterior fin length (FaL) and mantle length has been analysed by Pickford (1949*a*, pp. 51–3). The adult curve was used for specimen No. 99, and the rest were determined from the curve for larvae.

it was at least 60% of the length of the anterior fin. This would place the specimen in stage 3, but even this would be inappropriate to a larva of only 14 mm. mantle length whereas a mantle length of 20–21 mm. is entirely to be expected at this stage. The correction for specimen No. 103 is less striking since transitional specimens in the last stages of metamorphosis (stages 4–5) may range from 25 to 39 mm. in mantle length.

Specimen No. 96 is too badly damaged for measurement but estimates from the eye diameter and from anterior fin length indicate a probable mantle length of 24·5–27 mm. There is no trace of a posterior

fin, but, at a mantle length of 25 mm. or more, it is quite possible that the larval fin was in the last stages of resorption. The specimen is tentatively assigned to stage 4.

Specimen No. 97 is also interesting. Anterior fin buds cannot be seen on account of the poor condition of the specimen, yet, at a mantle length of 10·5 mm., it is most improbable that they were not originally present. The eye diameter indicates that the true mantle length may even have been somewhat greater, perhaps as much as 13 mm. The specimen may be assigned to stage 2 with some confidence and it may further be noted that, at the observed mantle length of 10·5 mm., the anterior fin rudiment was probably a triangular bud about 0·3 mm. in length.

Sex and stage. The preceding discussion permits a clear statement regarding developmental stages; sex is determined by the presence or absence of a penis or penis rudiment which is visible even in very young male larvae.

The collection contains one half-grown adult, specimen No. 99, a female. Two specimens, Nos. 103 and 104, are in the final stage of metamorphosis with only minute posterior fin rudiments. Both these specimens are males as also are three more which have been assigned to the last larval stage, viz. specimens No. 96, 98 and 102. As noted above, however, specimen No. 96 may really have already lost its larval fin. The remaining specimens consist of a four-finned larva (stage 3), which is specimen No. 101, a female, and two stage 2 larvae in which the anterior fin is a mere rudiment. One of the latter (specimen No. 97) cannot be sexed on account of poor preservation, nor can the anterior fin bud be seen although, as noted above, it must certainly have been present. Specimen No. 100 is rather well preserved although the mantle is everted, an anterior fin bud is present and the sex is almost certainly female as there is no trace of a penis rudiment.

Primary cirri. Previous investigations have brought to light the interesting possibility that there may be small racial differences between the *Vampyroteuthis* populations of the Atlantic and Indo-Pacific Oceans. Atlantic specimens appear to have one more pair of primary cirri, i.e. cirri that precede the first sucker, on the arms. The difference is not an absolute, all or nothing character, but far more Atlantic specimens have the larger number, and far more Indo-Pacific specimens the smaller.

Table 4. *Number of primary cirri*

Spec. No.	Left 1	Left 2	Left 3	Left 4	Right 1	Right 2	Right 3	Right 4	Comments
96	–	–	–	–	–	–	–	–	Condition does not permit an accurate count
97	8	7	6	6	?	7	6	6	–
98	8	7	7	6	8	7	7	6	–
99	8	7	6	5	8	?6–7	6	5	–
100	7	7	6	6	6+	6	6	6	One sucker on first arms, two on rest
101	?7	6	6	6	7	7	6	6	Very difficult to count
102	7	7	6	6	7	6	6	6	–
103	7	6	5	5	7	6	6	5	–
104	?7	–	–	5	7	6	5	4	First pair on R4 represented by a single (ventral) cirrus

The data for the Discovery specimens are tabulated in Table 4 and the results are summarized in Tables 5 and 6. It will be seen that the Discovery specimens contribute nothing towards the hypothesis of racial difference, in fact, for the first time, an Atlantic specimen (No. 104) is found to have a minimum number of four pairs of primary cirri. Nevertheless the overall data are still heavily weighted in favour of the racial hypothesis. The majority of Atlantic specimens have 8 or more pairs of primary cirri on the first or second arms (31 specimens out of 46); the majority of Indo-Pacific

specimens have seven or less (16 out of 26). Similarly on the third and fourth arms the majority of Atlantic specimens have six or more pairs (39 specimens out of 53), whereas the majority of Indo-Pacific specimens have five or less (19 specimens out of 29).

Table 5. *Summary of data on maximum number of pairs of primary cirri, situated normally on the first or second arms*

Group	Maximum number of pairs of primary cirri					Total no. specimens
	6	7	8	9	10	
Atlantic previous records	–	11	19	9*	2	41
'Discovery'	–	4	1	–	–	5
Totals	–	15	20	9*	2	46
Indo-Pacific previous records	1	14	8	–	–	23
'Discovery'	–	1	2	–	–	3
Totals	1	15	10	–	–	26

* Includes one specimen that may have possessed a tenth pair (Pickford, 1949*a*).

Table 6. *Summary of data on minimum number of pairs of primary cirri, situated normally on the third or fourth arms*

Group	Minimum number of pairs of primary cirri					Total no. specimens
	4	5	6	7	8	
Atlantic previous records*	–	12	28	7	1	48
'Discovery'	1	1	3	–	–	5
Totals	1	13	31	7	1	53
Indo-Pacific previous records	4	17	4	1	–	26
'Discovery'	–	1	2	–	–	3
Totals	4	18	6	1	–	29

* Includes data for the Bermuda series listed but not analysed previously (Pickford, 1950).

GEOGRAPHICAL DISTRIBUTION

The geographical distribution of the Discovery specimens is given in the list of specimens (Table 1) and shown graphically on the map (Fig. 1). Since none is from the Pacific this ocean has been omitted except in so far as its periphery appears on the maps of the Atlantic and Indian Oceans. To complete the picture it may be stated that there are five additional Pacific records, not shown in Fig. 1, which are rather uniformly distributed along a line between Panama and Australia, following the cruise of the 'Dana', 1928–30.

Six of the Discovery specimens are from the Eastern Atlantic, in the vicinity of the Guinea and Angola Basins. This is a region already well known to be populated by *Vampyroteuthis*, and in fact the type specimen came from 1° 56·7′ S and 7° 40·6′ E in the Gulf of Guinea.

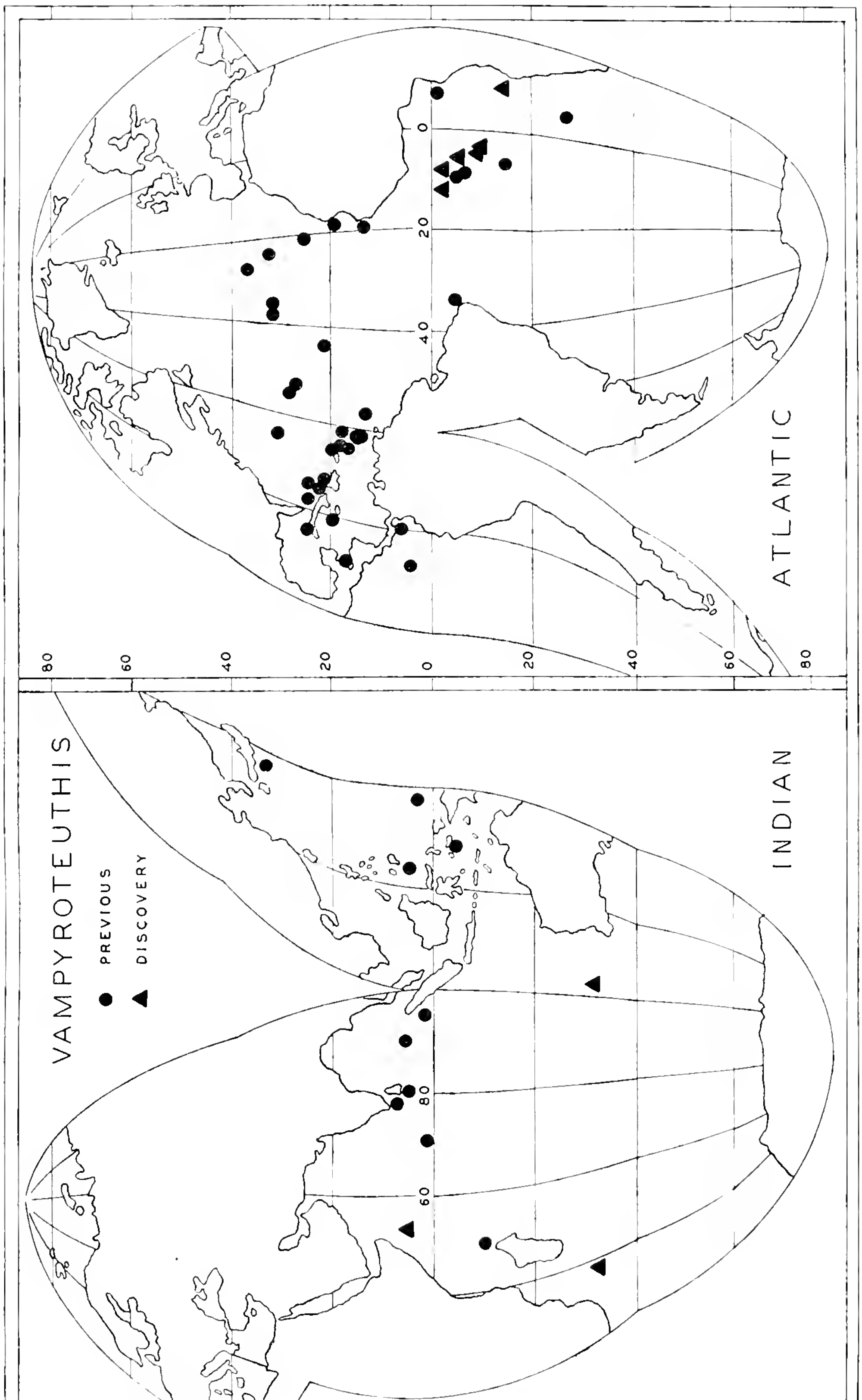

Fig. 1. Maps showing the distribution of *Vampyroteuthis infernalis* in the Indian Ocean (left) and in the Atlantic (right).

The three remaining specimens are more interesting since each one adds a new record from a hitherto unknown region. Specimen No. 98 is from the Somali Basin, near where the Red Sea discharges into the Arabian Sea. Its presence here is entirely to be expected, in view of adjacent records from north of Madagascar and west of Ceylon. Specimen No. 100 from off South Africa in the South Indian Ocean is a most welcome record confirming the hypothesis advanced previously (Pickford, 1946) that the *Vampyroteuthis* populations of the South Atlantic and Indian Oceans must be in free communication with each other by way of suitable water masses passing south of Cape Agulhas.

Finally, specimen No. 99 is of exceptional interest since it is the first record of *Vampyroteuthis* from off Western Australia. The writer has suggested that *Vampyroteuthis* probably occurs in suitable water south of Australia and that the Indo-Pacific populations may be in free communication by this route. The present record appears to favour this hypothesis but more data are required to establish the continuity south of Australia.

VERTICAL DISTRIBUTION

The sounding and depth of capture are listed in Table 7. Six of the nine specimens were taken in nets towed at accurately known depths that were determined with the aid of a depth recorder. Three of these nets were closed before being hauled to the surface, but the other three were hauled open to the surface, either because no closing mechanism was used or because the mechanism failed to operate. Nevertheless it is most probable that the specimens were taken at the depth of towing since the net was fishing at that depth for a much longer time than on the way to the surface. It has been necessary to make this assumption in all previous studies although, in the case of the Dana material it was possible to introduce a correction for specimens captured during lowering and raising of the net. This is not possible for the Discovery records.

Table 7. *Summary of data on net type, sounding and depth of capture*

Spec. No.	Station	Sounding (m.)	Net type*	Depth† (m.)	Depth recorder‡
96	269	—	TYF	600–700 (–0)§	DGB
97	287	—	TYF	800–1000 (–0)	DGB
98	1587	5098	TYF B	1250–800	DGP
99	1739	5400	TYF B	3000–2000 (–0)	DGP
100	1764	2430	N 450 B	1000–0	—
101	2059	4370	N 450 B	1400–0	—
102	2061	4390	N 450 B	1500–0	—
103	2065	4849	N 450 B	1600–1400	DGP
104	2080	5305	TYF B	1750–950‖	DGP

* TYF = Young fish trawl; B = oblique haul; N 450 = 4·5 m. tow net.

† The symbol (–0) means either that no closing mechanism was used or that 'the net failed to close at some intended intermediate depth and fished all the way to the surface'.

‡ DGB = Depth gauge, Budenberg pattern; DGP = Pressure depth gauge, a modification of the Budenberg pattern.

§ Note on original label 'Ceph. fragments (–0)'.

‖ Note on original label 'Caught in upper netting'.

The vertical distribution is in general agreement with previous investigations. The six Atlantic specimens were taken, presumably, in depths ranging from 600 to 1750 m. Forty-three out of 53 previously recorded Atlantic specimens were taken with towlines of 2000–4000 metres of wire (Pickford, 1950), i.e. at depths of 1000–2000 m. Similarly the three Indian Ocean specimens are from 800 to 3000 m., and previous records for the Indian Ocean are all from 1000 to 2000 m. estimated depth.

The only point of interest pertains to the shallowest depth at which the species may occur. In the Atlantic the 'Dana' captured two specimens at St. 1322, one with a towline of 1600 m.w., the other with 1900 m.w. In the Philippines Basin, at St. 3751, she took one specimen with a towline of only 1000 m.w. The 'Pawnee' took one Atlantic specimen with a towline of 1981 m.w. at St. 56, but this is so close to 2000 that it may well be disregarded. The difficulty with all these records is the interpretation. In the middle depths, with towlines of 2000–6000 m.w. it is probable that the approximate depth of capture may be at one-half the length of the towline. With shorter lengths of cable the matter becomes less certain and the 'Dana' considered that in shallower depths, with less than 1000 m.w., a better estimate of fishing depth was at one-third the length of the cable.

Using the deeper estimate we may say that previous records of *Vampyroteuthis* from shallower water have been made at depths of 800–890 m. in the Atlantic Ocean, and 500 m. in the Philippines Basin. If we convert these estimates to depths at one-third the length of the towline they become 533–660 m. and 333 m. respectively. The data for the Discovery specimens would be more decisive, since depth recorders were used, were it not for the fact that several of the nets were hauled to the surface without closing. However, it is certain that specimen No. 96 was not taken below 700 m. and most probable that it was captured at the depth of towing, 600–700 m. Similarly, specimen No. 97 could not have been taken below 1000 m. and was probably taken between 800 and 1000 m. In the case of specimen No. 98 the closing device operated successfully and we can definitely state that this animal was taken between 1250 and 800 m.

As far as the information goes it appears to indicate that previous estimates for shallow water captures should be taken at half the length of the cable and that the species rarely if ever occurs above 500 m.

In regard to proximity to the bottom, it will be noted that all the Discovery specimens were taken in middle depths over deep or very deep water. None could have been taken within even 1000 m. of the bottom.

Table 8. *Summary of hydrographic data*

Spec. No.	Prob. depth capture (m.)	Hydrogr. station*	Hydrographic data: Depth (m.)	Temp. (° C.)	Salinity (‰)	Density (σ_t)
96	600–700	265	600	6·88	34·56	27·11
			800	6·74	34·56	27·12
97	800–1000	289	800	6·27	34·50	27·15
			1000	4·68	34·50	27·33
98	1250–800	1588	790	8·69	35·22	27·37
			990	7·53	35·19	27·51
			1490	4·92	35·01	27·72
99	3000–2000	1740	1950	2·48	34·71	27·73
			2430	2·03	34·72	27·77
			2920	1·67	34·72	27·79
103	1600–1400	2062	1380	4·01	34·92	27·74
			1570	3·82	34·97	27·81
104	1750–950	2058†	990	4·06	34·58	27·47
			1190	3·87	34·73	27·61
			1390	3·75	34·85	27·71
			1590	3·55	34·93	27·80

* That nearest to station of capture and at about same date unless otherwise indicated. Data from the Station Lists (*Discovery Reports*, vol. 1, 22 and 24).

† The specimen was taken at Stn 2080 in October 1937, the hydrographic data are for April 1937.

HYDROGRAPHIC CORRELATIONS

The hydrographic data for stations adjacent to the place of capture and at depths corresponding to the probable depth of capture, are summarized in Table 8. Selected mean values used for plotting are given in Table 9. The writer is deeply interested in the distribution of bathypelagic marine organisms in relation to water types and has suggested the use of temperature-salinity charts for the

Table 9. *Selected or interpolated values of temperature and salinity at the most probable mean depth of capture, derived from Table 8 and used in plotting the distribution in relation to water types (Figs. 2, 3 and 4)*

Spec. No.	Selected depth (m.)	Estimated temp. (° C.)	Estimated salinity (‰)
96	700	6·80	34·56
97	900	5·40	34·50
98	990	7·53	35·19
99	2430	2·03	34·72
103	1475	3·90	34·95
104	1290	3·80	34·70

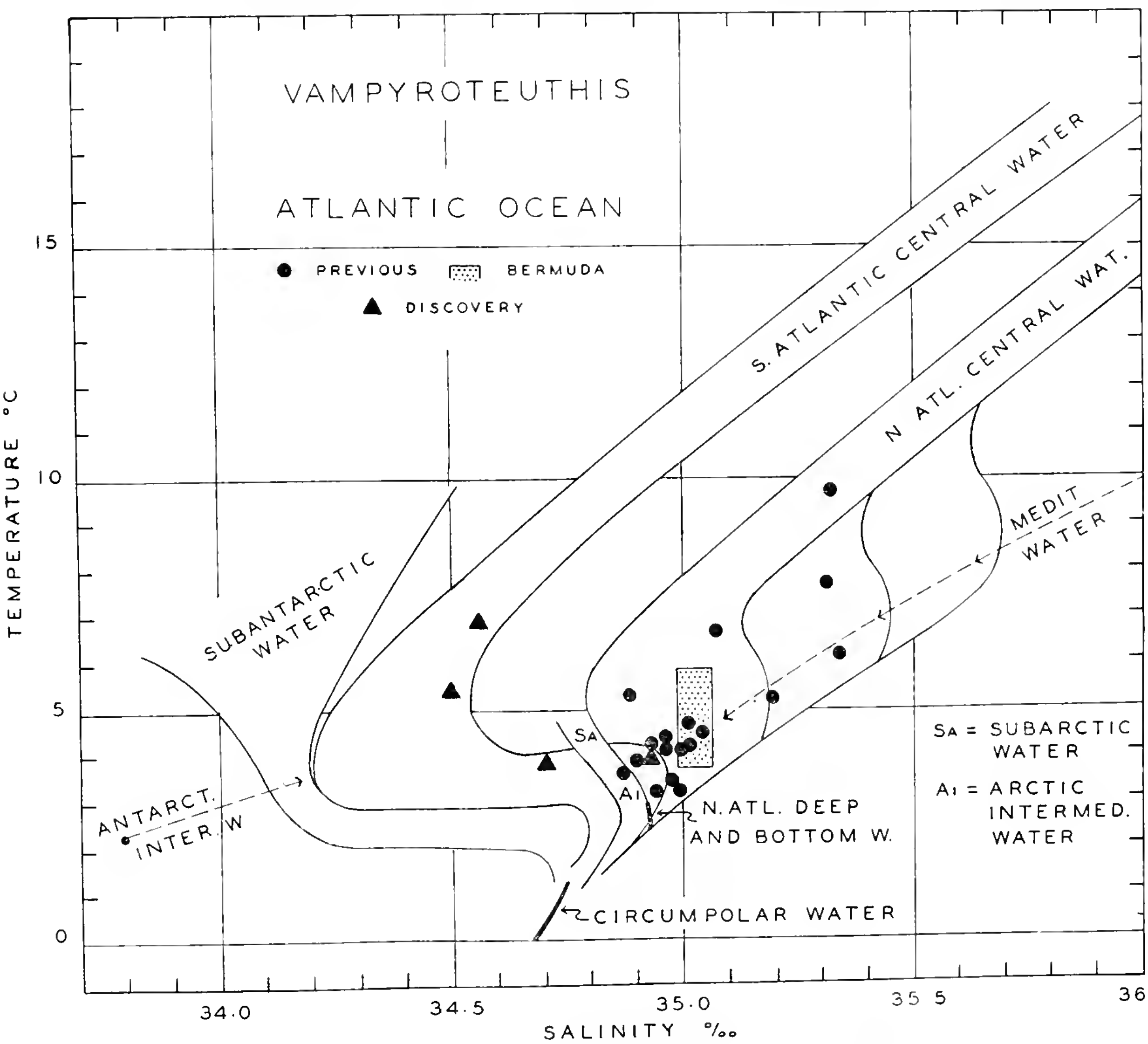

Fig. 2. The distribution of *Vampyroteuthis infernalis* in relation to the water masses of the Atlantic Ocean.

analysis of hydrographic correlations (Pickford, 1946). The distribution of *Vampyroteuthis* in relation to the water masses of the Atlantic and Indian Oceans is shown in Figs. 2 and 3. The names adopted here for the various water masses are those used by Sverdrup, Johnson & Fleming (1942). In the Atlantic the species inhabits the upper layers of the Deep Water and moves upwards into the North Atlantic Central Water. New records made by the 'Discovery' show that it also moves upwards into the South Atlantic Central Water. This was entirely to be expected, but it is satisfactory to have verification.

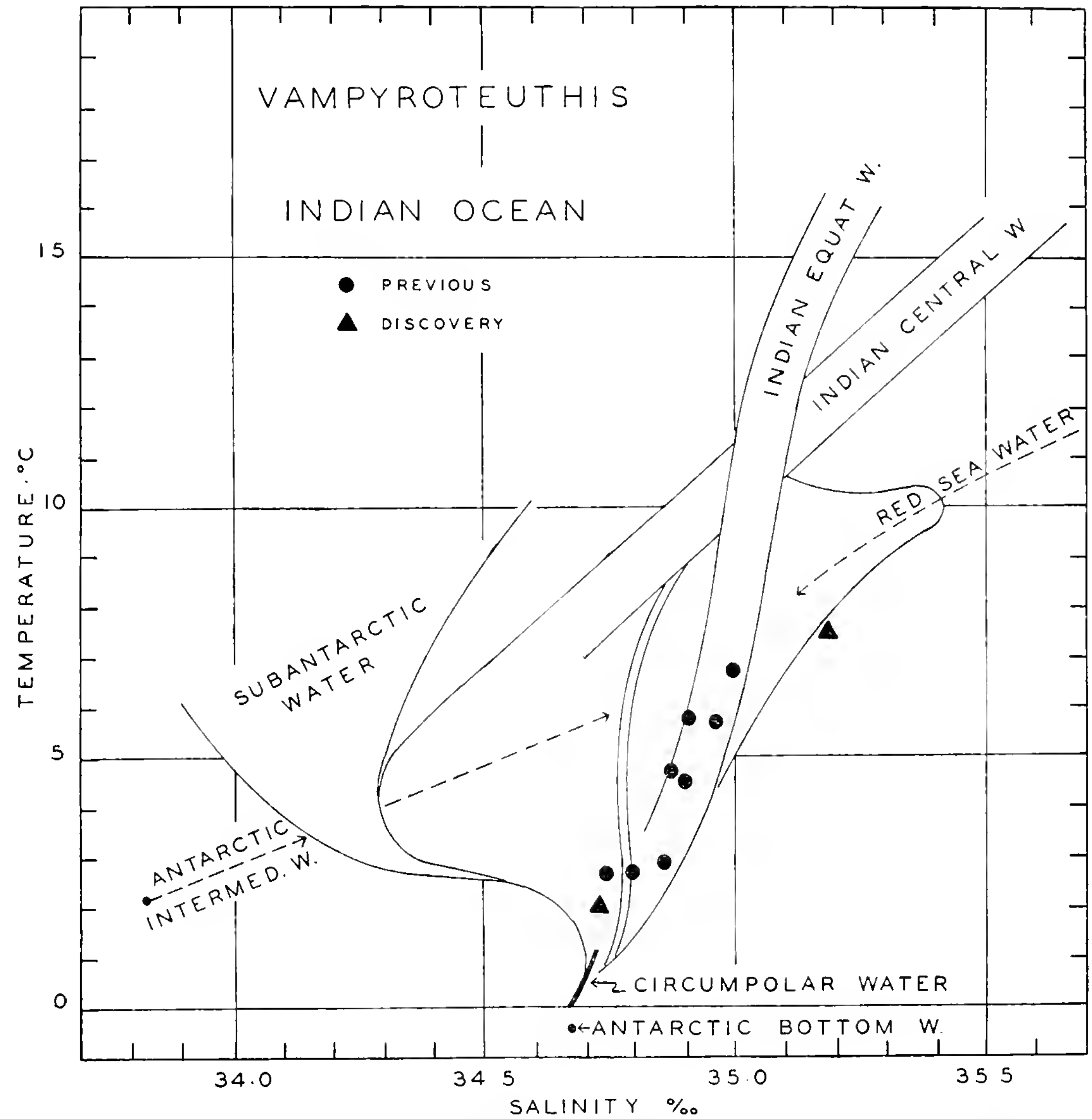

Fig. 3. The distribution of *Vampyroteuthis infernalis* in relation to the water masses of the Indian Ocean.

In the Indian Ocean the few previous records are from the Indian Deep Water and upwards into the Indian Equatorial Water. One of the two Discovery records is from the Deep Water. The other, specimen No. 98 from the Somali Basin, is from a region where Red Sea Water is flowing out to join the Equatorial Water. At the present time there are no records from Indian Central Water.

The distribution of *Vampyroteuthis* in relation to temperature, salinity, and density is further summarized in Fig. 4 in which the new records are indicated in solid black. Empirically the species appears to be restricted to water of salinities between 34·4 and 35·4‰, of temperatures between 2 and 10° C., and of densities between σ_t 27·0 and 27·9. Dr E. F. Thompson has suggested that the last

mentioned is the determining factor and that the species is passively caught in a layer of constant density. Nevertheless the animals appear to be strongly stenohaline and are not found in waters of suitable density when the salinity is less than 34·4‰. Yet there are cold waters of low salinity and appropriate density at suitable depths. The upper limits of temperature-salinity tolerance are more readily explainable since in passing them the animal would be led into regions above the oxygen minimum where light penetrates and so into what is well known to be a totally different life zone.

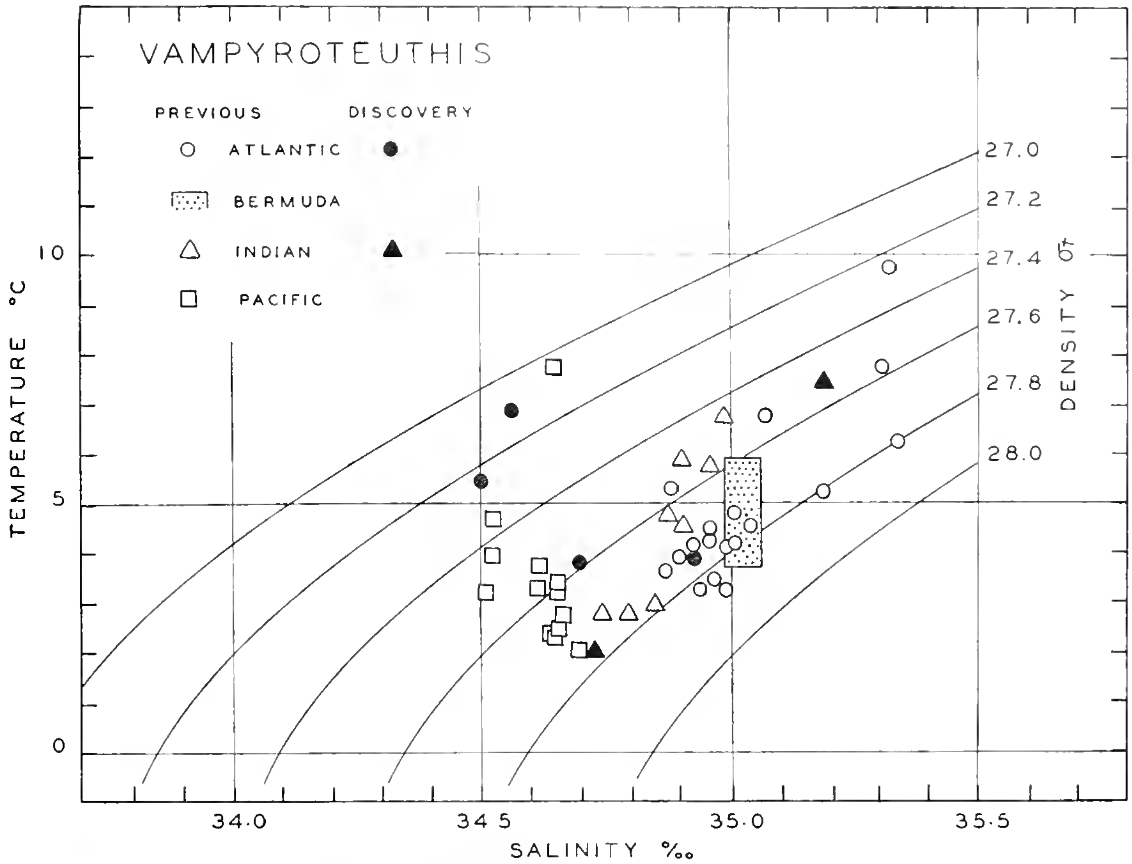

Fig. 4. The distribution of *Vampyroteuthis infernalis* in relation to salinity, temperature and density.

In regard to the individual records, it will be noted that the Discovery specimens from the South Atlantic Central Water fall among the Pacific group, whereas the specimen from the Somali Basin finds itself in water of high salinity and temperature, of a type hitherto known to be inhabited by *Vampyroteuthis* only in the Atlantic. Evidently, within the limits of temperature-salinity tolerance, the geographical region is of no importance.

SUMMARY

1. Nine specimens of *Vampyroteuthis infernalis* Chun were captured by the Discovery Expeditions between the years 1927 and 1937.

2. The colour of the living animal is deep purple rather than jet black. This colour is due to a red or purple pigment in the epidermal cells which fades after preservation. The oral face of the web is black, or perhaps deep purple, not brown as previously described. The latter colour is apparently an artifact of preservation.

3. Eye diameter and anterior fin length are used to adjust the observed mantle length in cases of damage, shrinkage or distortion. Subject to such correction the specimens are found to fall into size

ranges appropriate to their developmental fin stage. There is one immature adult, five metamorphosing larvae (stage 4 or 4–5), and three younger larvae.

4. The number of pairs of primary cirri adds nothing to the hypothesis that there is a racial difference in this respect between the Atlantic and Indo-Pacific populations. Nevertheless the tabulation of known data is still heavily weighted in favour of the view that Atlantic specimens tend to have an additional pair of primary cirri on all arms. One Atlantic specimen with a minimum of only four pairs is recorded.

5. The six Atlantic specimens are from the Guinea and Angola Basins where *Vampyroteuthis* is known to occur. The three Indian Ocean specimens provide a corresponding number of unique records, from the Somali Basin, the eastern extension of the Agulhas Basin and the region of junction of the Indo-Australian and South Australian Basins. The last two records tend to confirm the hypothesis of open communication between the *Vampyroteuthis* populations of the Atlantic, Indian and Pacific Oceans by pathways passing south of South Africa and south of Australia.

6. The vertical distribution of the Discovery specimens, from 600 to 3000 m., is rather accurately known through the use of closing nets and depth-recording gauges. The range corresponds with previous estimates in which depth of capture was taken to be at one-half the length of the cable. The upper limit for the species is probably not less than 500 m.

7. Hydrographical data are available for four Atlantic and two Indian Ocean specimens. Three Atlantic specimens are from South Atlantic Central Water, expected but not hitherto known to be inhabited by *Vampyroteuthis*. The specimen from the Somali Basin is from a region of high salinity and temperature where the Red Sea Water flows out into the Indian Equatorial Water. The two remaining specimens are from Atlantic Deep and Indian Deep Water respectively.

8. The newly recorded specimens are distributed within previously established co-ordinates delimiting the salinity (34·4–35·4‰), temperature (2–10° C.), and density (σ_t 27·0–27·9) tolerances of the species.

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DISCOVERY INVESTIGATIONS STATION LIST

R.R.S. 'WILLIAM SCORESBY'

1950

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DISCOVERY INVESTIGATIONS
STATION LIST

R.R.S. 'WILLIAM SCORESBY'

1950

(Plates XI, XII)

INTRODUCTION

This list contains particulars of the observations made by the R.R.S. 'William Scoresby' during her eighth commission, between January and November 1950. Station Lists including the earlier observations made by the same ship have already appeared in vols. I, II, IV and XXV of the *Discovery Reports*, and the present stations (WS 960–1107), although separated from the pre-war work by a gap of twelve years, are numerically continuous with it.

It was intended that the eighth commission of the 'William Scoresby' should mainly be devoted to whale-marking in tropical and sub-tropical waters, but a limited amount of oceanographical work and experimental fishing was also planned.

The first four stations (WS 960–963) were worked on the continental shelf and slope south-west of Ireland, in co-operation with the Marine Biological Association of the United Kingdom. Following this, a survey of the waters off the coast of South-West Africa (WS 964–1002) was made. After some fishing experiments (WS 1003–1012) off East London, a few oceanographical stations were worked in the central Indian Ocean (WS 1013–1020). Shore collections (WS 1021) were made at Mauritius, and two trawling stations (WS 1022, 1023) were worked south of Madagascar.

Unavoidable modifications in programme increased the amount of time available for oceanographical work, and made it possible to work two lines of stations across the Mozambique Current (WS 1024–1030) and the Agulhas Current (WS 1031–1040) in addition to the repetition of the survey off the South-West African coast (WS 1043–1107).

Salinity samples were analysed subsequently ashore, as on previous commissions of the R.R.S. 'William Scoresby', a necessity in view of the limited laboratory accommodation on so small a ship, but special arrangements were made for the estimation of phosphate and dissolved oxygen content on board. All such determinations were made within 10–20 hours of the collection of the samples.

Phosphate analysis was done by the Atkins-Denigès molybdenum blue method, and the colour comparison made in a Lovibond-type colorimeter with a series of thirty-three specially made glass slides, with colours flashed on to them, representing a range of 0·03–3·00 mg. atoms P m^3. These slides were precalibrated in a shore laboratory with standard phosphate solutions made up in phosphate-free sea water, obviating the need for salt-error correction. Dissolved oxygen content was determined by the usual Winkler method.

During the second survey off South-West Africa, a number of wire soundings were made to ascertain the nature of the bottom. These have been given station numbers, and the abbreviations denoting the nature of the bottom are those used by the Hydrographic Department of the Admiralty, 1946.[1] The following appear in this Station List:

bl	black	Di	diatom	h	hard	S	sand
br	brown	Fr	foraminifera	lt	light	Sh	shells
c	coarse	Gl	globerigina	M	mud	sk	speckled
Co	coral	gn	green	Oz	ooze	St	stones
d	dark	gy	grey	R	rock	y	yellow

[1] Chart No. 5011.

The symbol ∸ placed above the sounding figure signifies that no bottom was reached at that depth, and an asterisk following the depth indicates that the figure was obtained by echo-sounding.

Some of the bottom deposits off the South-West African coast emit a characteristic smell of hydrogen sulphide, and where this occurred H_2S has been placed beside the appropriate abbreviation.

The state of sea and swell is expressed by the appropriate number in the Douglas Sea and Swell Scale, which is as follows:

	Sea		Swell
0	Calm	0	No swell
1	Smooth	1	Low swell, short or average length
2	Slight	2	Low swell, long
3	Moderate	3	Moderate swell, short
4	Rough	4	Moderate swell, average length
5	Very rough	5	Moderate swell, long
6	High	6	Heavy swell, short
7	Very high	7	Heavy swell, average length
8	Precipitous	8	Heavy swell, long
9	Confused	9	Confused swell

The following Beaufort notation has been used to express the state of the weather:

b	blue sky with clear or hazy atmosphere, or sky not more than one-quarter clouded.
bc	sky between one-quarter and three-quarters clouded.
c	mainly cloudy (not less than three-quarters clouded).
d	drizzle or fine rain.
e	wet air without rain falling.
fe	wet fog.
m	mist.
o	overcast sky (i.e. whole sky covered with unbroken cloud).
p	passing showers.
r	rain.
z	dust haze; the turbid atmosphere of dry weather.

The times of the observations are given in ship's time expressed on the 24-hour system ending with midnight (0000). The hours to be added to, or subtracted from, ship's (or zone) time to give GMT are noted in the 'Remarks' column, this difference holding good until another entry is made. For example at Station WS 964, "GMT=zone−1 hr" means that one hour is to be subtracted from ship's time to give GMT. Times in heavy type refer to biological observations made between sunset and sunrise.

The following symbols are used for nets, apparatus, etc.:

B	Oblique.
BT	Bathythermograph, standard U.S. Navy pattern, OC 2A/S, manufactured by Wallace and Tiernan Products, Inc., New Jersey.
DC	Conical dredge. Mouth 16 in. (40·5 cm.) in diameter, with a canvas bag.
DLH	Large rectangular dredge. Heavy pattern, 4 ft. (1·2 m.) long.
H	Horizontal.
KT	Kelvin sounding tube.
LH	Hand lines.
LL	Long lines (a fleet of two lines, each 460 fathoms long).

LS	Experimental improvised line, 235 fathoms long, with end made fast to ship. Outboard end carried a 50 lb. weight and was rigged with 16 traces and hooks.
N 50	50 cm. silk tow-net. Mouth circular, 50 cm. (19·5 in.) diameter: 200 meshes to the linear inch.
N 70	70 cm. tow-net. Mouth circular, 70 cm. (27·5 in.) diameter: mesh graded, at cod-end of silk, with 74 meshes to the linear inch.
N 100	1 m. tow-net. Mouth circular, 1 m. (3·3 ft.) diameter: stramin, with 10–12 meshes to the linear inch.[1]
NH	Hand net.
OTC	Commercial otter trawl. Head rope 74 ft. (22·6 m.) long; mesh at cod-end $1\frac{1}{2}$ in. (3·8 cm.).
Sh. Coll.	Shore collecting.
SSL	Lumby surface sampler, for collecting surface water samples while under weigh. Modified version, as described by J. R. Lumby 1928.[2]
TNL	Large fish trap, $12 \times 6 \times 6$ ft.: a rigid metal frame covered with wire netting of 1 in. mesh, and having two funnel-shaped entrances.
TYF	Young fish trawl. A bag of stramin, 10–12 meshes to the linear inch, attached to a circular frame 2 m. (6·6 ft.) in diameter, with a bucket at the cod-end.
V	Vertical.

The addition of the symbols B, H or V to those used for the tow-nets indicates whether they were hauled obliquely, horizontally or vertically. Where the depth interval indicates that a net fished vertically was closed, this was effected on the Nansen principle. The maximum depths reached by horizontal and oblique nets were determined by the use of Kelvin sounding tubes, and this is recorded by insertion of the symbol KT in the 'Remarks' column. Wire angles, expressed as deviations from the vertical and determined by a simple inclinometer, are given for water samples collected with the Nansen-Pettersson water-bottle, but no correction to the depth has been applied. Depths of reversing water-bottles have been calculated from the thermometric depths, using the method of Pollack.[3] The small index figure placed against the figure for depth shows from which hoist of water bottles the sample was obtained.

The Bathythermograph conformed to the standard of accuracy laid down by the makers; it was calibrated frequently during the commission, showing negligible variance from the original calibration. The depth limit of this instrument is 450 ft. (138 m.). It was our practice to work it with the ship hove to, since we worked a vertical net at all our BT stations, and therefore no time was lost by departing from the normal U.S. Navy method of using the instrument with the ship under way. This explains why we were so frequently able to work the instrument down to the lower limit of its range.

[1] Earlier versions of the N 100 were of graded mesh, but also had stramin at the cod-end.

[2] Journ. du Conseil, III, No. 3, pp. 340–50.

[3] Pollack, M. J., 1950. *Notes on determining the depth of sampling in serial oceanographic observations.* Journ. Mar. Research, IX, No. 1.

R.R.S. 'WILLIAM SCORESBY'
STATIONS WS 960–1107

18. i. 1950—14. x. 1950

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 960	50° 34′ N, 10° 40′ W	1950 18 i	1430–1600	168*	Var	2	NW	—	—	—	o	1037·0	8·9	—
WS 961	50° 34′ N, 11° 00′ W	18 i	1731–1934	515*	Lt airs	< 1	—	—	NW	2	bc	1037·0	8·9	—
WS 962	50° 34′ N, 11° 10′ W	18 i	2033–2355	922*	Lt airs	< 1	—	—	NW	2	bc	1040·0	8·9	—
WS 963	From 50° 34′ N, 11° 30′ W to 50° 41′ N, 11° 43′ W	19 i	0805–1750	1311*	SE	17–27	SE	3–4	SE	4	o	1032·0	10·0	—
WS 964	19° 44′ S, 10° 46′ E	4 iii	1220–1246	—	SSE	11–21	SSE	3	SSE	4	bc	1014·0	20·6	19·4
WS 965	19° 44′ S, 11° 04′ E	4 iii	1440–1459	1110*	SSE	11–21	SSE	3	SSE	4	bc	1013·0	20·6	19·4

Station	Age of moon (days)	Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	P total	O₂ c.c. litre	Gear	Depth (metres)	Time From	To	Remarks
WS 960	0	0	—	—	11·46	35·47	27·08	0·51	—	—	N 70 V	50–0	1440	—	GMT = Ship's time
		10	—	—	11·46	35·46	27·07	0·53	—	—	,,	100–50			
		20	—	—	11·46	35·45	27·06	0·49	0·61	—	,,	150–100	—	1520	
		50	—	—	11·45	35·44	27·05	0·48	—	—	N 100 B	80–0	1553	1600	KT
		100	—	—	11·46	35·45	27·06	0·48	0·63						
		150	—	—	11·48	35·42	27·04	0·48	0·62						
WS 961	0	0	—	—	11·25	35·43	27·08	0·52	—	—	N 70 V	100–0	1737		
		10	—	—	11·27	35·45	27·09	0·54	—	—	,,	200–100			
		20	—	—	11·26	35·43	27·08	0·53	0·72	6·10	,,	300–200			
		50	—	—	11·25	35·43	27·08	0·54	—	—	,,	500–300	—	1840	
		100	—	—	11·26	35·42	27·08	0·56	0·66	5·93					
		150	—	—	11·27	35·46	27·10	0·58							
		200	—	—	11·26	—	—	0·53	0·73	5·90					
		250	—	—	11·25	35·47	27·12	0·53							
		400	—	—	10·94	35·38	27·11	0·75							
WS 962	0	0	—	—	11·31	—	—	0·56	—	—	N 70 V	100–0	2040		
		10	—	—	11·32	35·45	27·08	0·55	—	—	,,	200–100			
		20	—	—	11·32	35·43	27·07	0·53	0·72	5·95	,,	300–200			
		50	—	—	11·31	35·44	27·08	0·53	—	—	,,	500–300			
		100	—	—	11·30	35·45	27·09	0·55	0·69	6·23	,,	700–550	—	—	Closed prematurely
		150	—	—	11·31	—	—	0·54	—	—	,,	900–700	—	2230	
		200	—	—	11·32	35·44	27·07	0·56	0·71	6·11					
		300[2]	304	—	11·19	35·44	27·10	0·67							
		410[2]	—	—	10·88	35·38	27·12	0·72	—	5·53					
		520[2]	517	—	10·63	35·38	27·16	0·83							
		600[1]	599	—	10·34	35·36	27·20	1·00							
		810[1]	—	—	9·71	35·45	27·37	1·18	1·39						
		910[1]	912	—	9·47	35·46	27·42	1·13	1·32	4·38					
WS 963	1	0	—	—	11·27	35·44	27·08	0·54	—	5·62	N 70 V	1300–1100	0810		
		10	—	—	11·26	35·44	27·09	0·56	—	—	,,	1100–900			
		20	—	—	11·25	35·39	27·05	0·55	0·74	5·30	,,	900–700			
		50	—	—	11·25	35·40	27·06	0·54	0·71	—	,,	700–500			
		100	—	—	11·25	35·43	27·08	0·55	0·70	6·15	,,	450–0	—	—	Foul wire
		150	—	—	11·26	35·39	27·05	0·53	—	—	,,	200–100			
		200	—	—	11·29	35·42	27·07	0·54	0·70	6·30	,,	100–0	—	1350	
		250	—	—	11·29	35·44	27·08	0·54	—	—	,,	500–300	1630	—	Bad stray on nets
		300	—	—	11·16	35·39	27·07	0·65	—	—	,,	300–200	—	1730	
		400	—	—	10·89	35·41	27·14	0·75	0·93	5·72					
		510[1]	505	—	10·54	35·40	27·19	0·97							
		590[1]	—	—	10·25	35·36	27·21	0·94	1·05	4·10					
		680[1]	681	—	10·03	35·38	27·27	1·01							
		790[3]	791	—	9·72	35·44	27·36	1·04	1·21	4·71					
		850[3]	—	—	9·57	35·45	27·39	1·13							
		910[3]	911	—	9·47	35·47	27·43	1·12	1·31	4·38					
		970[2]	965	—	9·30	35·47	27·46	1·13	1·34	4·37					
		1000[2]	—	—	8·96	35·47	27·51	1·19	1·32	4·41					
		1040[2]	1043	—	8·81	35·46	27·53	1·16	1·30	4·52					
		1100[1]	1103	—	8·62	—	—	1·20	1·33	4·74					
		1200[1]	—	—	8·12	35·46	27·64	1·19	1·33	4·57					
		1310[1]	1309	—	7·56	35·37	27·65	1·22	—	4·82					
WS 964	15	0	—	—	21·7	—	—	0·13	—	—	BT	138–0	1225	1235	GMT = zone − 1 hr
		10	—	—	21·6	—	—	—	—	—	N 50 V	100–0	1229	1242	
		20	—	—	21·4	—	—	—	—	—	SSL	0	1242	1246	
		30	—	—	21·4										
		50	—	—	15·7										
		75	—	—	14·4										
		100	—	—	13·7										
		138	—	—	13·0										
WS 965	15	0	—	—	21·7	—	—	0·20	—	—	BT	138–0	1445	1453	
		10	—	—	21·5	—	—	—	—	—	N 50 V	100–0	1445	1453	
		20	—	—	21·3	—	—	—	—	—	SSL	0	1455	1459	

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 965 *cont.*	19° 44′ S, 11° 04′ E	1950 4 iii												
WS 966	19° 44′ S, 11° 22′ E	4 iii	1655–1714	683*	SSE	7–16	SSE	3	SSE	4	bc	1013·0	20·6	19·4
WS 967	19° 44′ S, 11° 41′ E	4 iii	1915–1935	376*	SE × S	11–16	SSE	4	SSE	4	o	1014·4	20·0	18·9
WS 968	19° 44′ S, 12° 01′ E	4 iii	2130–2149	304*	SE	7–10	SSE	3	SSE	3	o	1014·4	19·4	18·9
WS 969	19° 44′ S, 12° 20′ E	4–5 iii	2345–0004	179*	SSE	5	S	2	S	2	bc	1012·4	18·9	18·3
WS 970	19° 44′ S, 12° 40′ E	5 iii	0200–0217	113*	S	5	S	2	S	2	bc	1011·0	18·3	17·8
WS 971	20° 11′ S, 12° 30′ E	5 iii	0600–0619	204*	S	4–10	S × W	2	S × W	4	o	1013·0	18·3	17·2

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³		O_2 c.c. litre	Gear	Depth (metres)	TIME		
								P inorganic	P total				From	To	
WS 965 *cont.*	15	30	—	—	21·3										
		40	—	—	21·3										
		50	—	—	17·5										
		75	—	—	14·7										
		100	—	—	14·1										
		138	—	—	12·8										
WS 966	15	0	—	—	21·75	—	—	0·20	—	—	N 50 V	100–0	1657	1707	Surface temperature by Nansen-Pettersson water-bottle
		10	—	—	21·6	—	—	—	—	—	BT	138–0	1707	1714	
		20	—	—	21·5										
		30	—	—	21·4										
		40	—	—	16·5										
		50	—	—	15·6										
		75	—	—	14·1										
		100	—	—	13·3										
		138	—	—	12·6										
WS 967	15	0	—	—	21·6	—	—	0·20	—	—	N 50 V	100–0	1917	1929	
		10	—	—	21·5	—	—	—	—	—	BT	138–0	1925	1935	
		20	—	—	18·9	—	—	—	—	—	SSL	0	1932	1935	
		30	—	—	17·0										
		40	—	—	15·7										
		50	—	—	15·1										
		75	—	—	14·2										
		100	—	—	13·6										
		138	—	—	12·8										
WS 968	15	0	—	—	19·5	—	—	0·50	—	—	BT	138–0	2135	2145	
		10	—	—	19·5	—	—	—	—	—	N 50 V	100–0	2137	2143	
		20	—	—	19·3	—	—	—	—	—	SSL	0	2145	2149	
		30	—	—	18·5										
		50	—	—	16·8										
		75	—	—	15·2										
		100	—	—	14·6										
		138	—	—	13·0										
WS 969	15	0	—	—	18·7	—	—	0·83	—	—	N 50 V	100–0	2349	0000	
		10	—	—	18·4	—	—	—	—	—	BT	138–0	2350	0000	
		20	—	—	18·3	—	—	—	—	—	SSL	0	0000	0004	
		30	—	—	17·2										
		40	—	—	15·7										
		50	—	—	15·2										
		75	—	—	15·0										
		100	—	—	14·8										
		138	—	—	14·6										
WS 970	16	0	—	—	18·7	—	—	0·46	—	—	N 50 V	100–0	0202	0212	
		10	—	—	18·4	—	—	—	—	—	BT	110–0	0205	0212	
		20	—	—	17·0	—	—	—	—	—	SSL	0	0215	0217	
		30	—	—	16·6										
		50	—	—	15·8										
		75	—	—	15·4										
		100	—	—	14·8										
		110	—	—	14·7										
WS 971	16	0	—	—	19·1	—	—	0·42	—	—	N 50 V	100–0	0602	0612	
		10	—	—	19·1	—	—	—	—	—	BT	138–0	0605	0615	
		20	—	—	19·0	—	—	—	—	—	SSL	0	0615	0619	
		30	—	—	18·8										
		40	—	—	17·4										
		50	—	—	16·6										
		75	—	—	15·4										
		100	—	—	14·4										
		138	—	—	13·5										

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. ° C. Dry bulb	Air Temp. ° C. Wet bulb
WS 972	20° 36′ S, 12° 20′ E	1950 5 iii	1015–1031	344*	SSW	7–10	S	2	S	3	o	1016·0	18·9	17·8
WS 973	21° 07′ S, 12° 10′ E	5 iii	1429–1452	—	S	11–16	S	3	SSW	4	o	1014·0	18·9	18·3
WS 974	21° 35′ S, 11° 58′ E	5 iii	1848–1900	—	SE	17–21	SSE	3	SSE	5	o	1014·2	18·3	17·8
WS 975	22° 00′ S, 11° 51′ E	5 iii	2300–2315	—	SSE	17–21	SSE	4	SSE	4	o	1014·6	18·3	17·2
WS 976	From 22° 50′ S, 11° 38′ E	6 iii	0750–	*ca.* 3098 y.Gl.Oz	SE	11–16	SSE	3	SSE	4	o	1013·0	18·9	17·8
	to 22° 48′ S, 11° 35′ E		1745		SSE	11–16	S	3	S	4	bc	1010·0	20·0	18·3
WS 977	From 22° 39′ S, 12° 16′ E	6 iii–	2103–	—	SSE	11–16	SSE	3	SSE	4	o	1011·0	18·3	17·2
	to 22° 33′ S, 12° 17′ E	7 iii	0345	—	S × W	5	S × W	1	S	2	o	1013·0	18·3	17·8

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	P total	O₂ c.c. litre	BIOLOGICAL OBSERVATIONS Gear	Depth (metres)	TIME From	To	Remarks
WS 972	16	0	—	—	19·6	—	—	0·38	—	—	**BT**	138–0	1020	1027	
		10	—	—	19·6	—	—	—	—	—	**N 50 V**	100–0	1021	1027	
		20	—	—	19·6	—	—	—	—	—	**SSL**	0	1028	1031	
		30	—	—	18·3										
		40	—	—	16·0										
		50	—	—	15·1										
		75	—	—	14·5										
		100	—	—	14·0										
		138	—	—	13·2										
WS 973	16	0	—	—	20·1	—	—	0·33	—	—	**N 50 V**	100–0	1430	1445	
		10	—	—	20·1	—	—	—	—	—	**BT**	138–0	1433	1443	
		20	—	—	19·9	—	—	—	—	—	**SSL**	0	1449	1452	
		30	—	—	16·5										
		40	—	—	15·4										
		50	—	—	14·3										
		75	—	—	13·0										
		100	—	—	12·7										
		138	—	—	12·1										
WS 974	16	0	—	—	20·1	—	—	—	—	—	**BT**	138–0	**1855**	**1900**	
		10	—	—	20·0	—	—	—	—	—	**N 50 V**	100–0	**1855**	**1900**	
		20	—	—	20·0										
		30	—	—	19·1										
		40	—	—	15·9										
		50	—	—	15·3										
		75	—	—	14·4										
		100	—	—	13·7										
		138	—	—	12·9										
WS 975	16	0	—	—	18·7	—	—	—	—	—	**N 50 V**	100–0	**2305**	**2314**	
		10	—	—	19·0	—	—	—	—	—	**BT**	138–0	**2305**	**2315**	
		20	—	—	19·0										
		30	—	—	19·0										
		40	—	—	15·6										
		50	—	—	15·0										
		75	—	—	14·1										
		100	—	—	13·4										
		138	—	—	12·4										
WS 976	17	0	—	—	19·31	35·32	25·20	0·58	—	5·37	**N 50 V**	100–0	0805	0813	
		10	—	—	19·31	35·24	25·14	0·58	—	—	**N 70 V**	1000–750	1001		
	17	20	—	—	19·31	35·24	25·14	0·50	—	5·39	,,	750–500			
		30	—	—	19·29	35·26	25·17	0·58	—	—	,,	500–250			
		50	—	—	19·19	35·24	25·18	0·58	—	5·26	,,	250–100			
		75	—	—	14·29	35·23	26·32	0·92	—	—	,,	100–50			
		100	—	—	13·36	35·23	26·51	1·08	—	4·18	,,	50–0	—	1220	
		150	—	—	12·14	35·05	26·61	1·25	—	—	**N 50 V**	100–0	1225	1240	
		200	—	—	11·11	34·94	26·73	1·59	—	4·21	**N 100 B**	98–0	1532	1745	KT
		300	—	—	9·20	34·67	26·85	1·68	—	3·48	**TYFB**				
		400	—	—	7·36	34·52	27·01	1·68	—	3·42	**N 100 H**	5–0	1533	1553	
		500[3]	501	—	6·06	34·52	27·19	2·36	—	3·12					
		700[3]	—	—	4·77	34·50	27·32	2·23	—	3·17					
		900[3]	897	—	4·05	34·53	27·43	2·36	—	3·19					
		1100[2]	1099	—	3·57	34·69	27·60	2·36	—	—	—	—	—	—	Depth doubtful
		1400[2]	—	—	3·34	34·70	27·64	2·10	—	3·94	—	—	—	—	Closed prematurely
		1450[2]	1452	—	3·27	34·70	27·65	1·85	—	4·38					
		2420[1]	2424	—	2·87	34·91	27·85	1·59	—	4·64	—	—	—	—	†Filtered from ooze
		2920[1]	—	—	2·58	34·82	27·81	1·68	—	4·52	—	—	—	—	Deep hoist hit bottom
		3098[1]	3098	—	2·51	34·78	27·78	2·75†	—	—					
WS 977	17	0	—	—	18·38	35·24	25·38	0·50	—	5·30	**N 50 V**	100–0	**2112**		Failed to close
		10	—	—	18·38	35·27	25·41	0·58	—	—	**N 70 V**	1000–0	—	—	
	18	20	—	—	18·37	35·27	25·41	0·50	—	5·37	,,	1000–750			
		30	—	—	15·89	35·30	26·02	1·08	—	—	,,	750–500			
		50	—	—	14·12	35·20	26·34	1·08	—	3·78	,,	500–250			

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 977 *cont.*	From 22° 39′ S, 12° 16′ E to 22° 33′ S, 12° 17′ E	1950 6 iii–7 iii												
WS 978	22° 28′ S, 12° 42′ E	7 iii	1000–1304	932*	ESE	2	SE	1	SSE	1	o	1013·0	17·8	17·2
WS 979	22° 47′ S, 13° 35′ E	7 iii	1930–2320	139*	WSW	2	—	0	—	0	o	1011·0	16·7	16·1
WS 980	22° 44′ S, 14° 08′ E	8 iii	0240–0512	106*	Calm	0	—	1	S	1	om	1010·0	16·7	16·7
WS 981	22° 44′ S, 14° 20′ E	8 iii	0627–0813	64*	Calm	0	—	0	S × W	1	bc	1010·0	17·8	17·2
WS 982	23° 22′ S, 14° 11′ E	9 iii	1500–1550	124* bl.gn. Di.M	W × N	5	W × N	1	SSW	2	bc	1012·0	20·0	18·9
WS 983	23° 49′ S, 13° 57′ E	9 iii	1944–2000	201*	Calm	0	W × N	1	SSW	2	b	1013·7	18·9	17·8
WS 984	24° 20′ S, 13° 38′ E	10 iii	0000–0022	325*	Calm	0	—	0	SSW	2	bc	1013·7	17·8	17·2

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remark
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σ_t	Mg-atom m.³ P inorganic	Mg-atom m.³ P total	O_2 c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 977 *cont.*	18	75	—	—	13·22	35·17	26·50	0·88	—	—	**N 70 V**	250–100			
		100	—	—	12·68	35·06	26·52	1·25	—	3·39	,,	100–50			
		150	—	—	11·66	35·03	26·69	1·42	—	—	,,	50–0	—	**0019**	
		200	—	—	10·90	34·91	26·75	1·85	—	2·64					
		300	—	—	9·25	34·78	26·93	2·23	—	0·92					
		400	—	—	8·11	34·66	27·01	2·23	—	1·26					
		600	—	—	5·99	34·52	27·20	2·23	—	2·38					
		820[2]	818	—	4·35	34·34	27·25	2·23	—	3·12					
		1490[1]	1493	—	3·35	34·70	27·64	1·85	—	4·07					
WS 978	18	0	—	—	18·16	35·23	25·43	0·75	—	5·16	**N 70 V**	750–500	1010		
		10	—	—	17·96	35·24	25·48	1·00	—	—	,,	500–250	—	—	Closed prematurely: hauls repeated
		20	—	—	17·92	35·25	25·49	0·88	—	3·17	,,	250–100	—	—	
		30	—	—	14·76	35·25	26·23	1·76	—	—	,,	100–50			
		50	—	—	14·29	35·22	26·32	1·76	—	5·09	,,	50–0			
		75	—	—	13·54	35·17	26·44	1·98	—	—	,,	500–350			
		100	—	—	13·08	35·16	26·51	1·98	—	2·19	**N 50 V**	100–0	—	1228	
		150	—	—	12·09	35·06	26·63	2·55							
		200	—	—	10·95	34·80	26·65	1·85	—	2·85					
		300	—	—	9·38	34·69	26·83	1·85	—	1·89					
		400	—	—	7·94	34·61	27·01	2·10	—	1·46					
		600[1]	604	—	5·70	34·45	27·17	2·75	—	2·31					
		820[1]	824	—	4·22	34·46	27·35	2·81	—	3·21					
WS 979	18	0	—	—	16·68	35·12	25·70	0·20	—	8·07	**OTC**	146	**1930**	**2210**	Trawl fouled medusae and amphipods
		10	—	—	16·17	35·13	25·82	0·33	—	—	**NH**	0	**2205**		
		20	—	—	15·31	35·10	26·00	0·33	—	4·78	**N 50 V**	100–0	**2225**		
		30	—	—	13·66	35·16	26·39	1·68	—	—	**N 70 V**	50–0			
		50	—	—	13·08	35·10	26·47	0·92	—	2·21	,,	100–50	—	**2255**	
		75	—	—	12·63	35·10	26·56	1·08							
		100	—	—	12·43	35·09	26·59	1·85	—	1·19					
WS 980	19	0	—	—	16·97	35·15	25·66	0·25	—	6·43	**N 70 V**	100–50	**0255**		
		10	—	—	15·42	35·14	26·00	2·49	—	—	,,	50–0			
		20	—	—	14·32	35·15	26·25	2·75	—	2·56	**N 50 V**	100–0	—	**0325**	
		30	—	—	13·32	35·13	26·44	2·49	—	—	**LH**	*ca.* 5	—	**0300**	
		50	—	—	13·15	35·17	26·52	3·01	—	0·13					
		75	—	—	12·91	35·15	26·55	2·61							
		100	—	—	12·70	35·10	26·55	2·61	—	0·38					
WS 981	19	0	—	—	16·69	35·15	25·72	1·42	—	0·33	**N 70 V**	50–0	0635		
		10	—	—	14·92	35·13	26·11	1·68	—	—	**N 50 V**	55–0	—	0701	
		20	—	—	13·52	35·10	26·38	2·10	—	0·88	**N 100 H**	5–0	0753	0813	
		30	—	—	13·41	35·11	26·42	2·88							
		50	—	—	13·34	35·10	26·42	2·95	—	0·11					
WS 982	20	0	—	—	16·6	—	—	—	—	—	**DC**	124	1510	1525	GMT = zone − 2 hrs
		10	—	—	15·5	—	—	—	—	—	**BT**	120–0	1535	1540	
		20	—	—	14·2	—	—	—	—	—	**N 50 V**	100–0	1540	1550	Khaki-coloured water
		30	—	—	13·8										
		50	—	—	13·1										
		75	—	—	12·8										
		100	—	—	12·6										
		120	—	—	12·5										
WS 983	20	0	—	—	18·4	—	—	—	—	—	**N 50 V**	100–0	**1950**	**2000**	
		10	—	—	16·5	—	—	—	—	—	**BT**	138–0	**1953**	**2000**	
		20	—	—	15·1										
		30	—	—	14·0										
		50	—	—	13·2										
		75	—	—	12·6										
		100	—	—	12·2										
		138	—	—	11·9										
WS 984	21	0	—	—	17·0	—	—	—	—	—	**N 50 V**	100–0	**0010**	**0020**	
		10	—	—	16·3	—	—	—	—	—	**BT**	138–0	**0015**	**0022**	

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 984 *cont.*	24° 20′ S, 13° 38′ E	1950 10 iii												
WS 985	24° 50′ S, 13° 20′ E	10 iii	0422–0438	768*	W × S	5	—	0	SSW	2	b	1015·5	17·2	16·7
WS 986	From 25° 15′ S, 13° 06′ E	10 iii	0805–	—	Calm	0	—	0	SSW	2	b	1016·4	17·2	16·7
	to 25° 13′ S, 13° 08′ E		1407	—	Calm	0	—	0	SSW	2	b	1016·0	20·0	18·3
WS 987	25° 13′ S, 13° 43′ E	10 iii	1810–2000	293*	Calm	0	—	0	SSW	2	b	1015·9	20·0	18·9
WS 988	25° 12′ S, 14° 22′ E	11 iii	0026–0132	135*	S	7–10	S	1	S	1	b	1014·0	16·7	15·6
WS 989	25° 11′ S, 14° 39′ E	11 iii	0247–0345	70*	SSW	7–10	SSW	2	S	1	b	1013·5	16·7	15·6
WS 990	From 25° 35′ S, 14° 27′ E to 25° 36′ S, 14° 24′ E	11 iii	0855–1228	143* gn.-bl. c.M & Sh	SSW	11–16	SSW	2	SSW	1	bc	1013·5	16·7	15·6

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O₂ c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 984 *cont.*	21	20	—	—	15·4										
		50	—	—	14·4										
		60	—	—	13·4										
		75	—	—	13·0										
		100	—	—	12·4										
		138	—	—	11·6										
WS 985	21	0	—	—	16·8	—	—	—	—	—	**N 50 V**	100–0	**0425**	**0438**	
		10	—	—	15·7	—	—	—	—	—	**BT**	138–0	**0433**	**0438**	
		20	—	—	15·5										
		30	—	—	15·1										
		40	—	—	14·0										
		50	—	—	13·4										
		75	—	—	12·8										
		100	—	—	12·3										
		138	—	—	11·7										
WS 986	21	0	—	—	17·10	35·00	25·51	1·08	—	5·92	**N 50 V**	100–0	0825		
		10	—	—	16·34	34·97	25·67	1·42	—	—	**N 70 V**	1000–750			
	21	20	—	—	16·29	34·99	25·69	1·21	—	5·88	,,	750–500			
		30	—	—	15·87	35·00	25·80	1·08	—	—	,,	500–250			
		50	—	—	14·70	35·05	26·09	1·42	—	4·56	,,	250–100			
		75	—	—	13·24	34·99	26·36	1·51	—	—	,,	100–50			
		100	—	—	12·26	34·92	26·49	1·34	—	4·05	,,	50–0	—	1118	
		150	—	—	11·61	34·93	26·63	1·25	—	—	**NH**	0			
		200	—	—	10·84	34·88	26·73	1·68	—	2·53					
		300	—	—	9·44	34·74	26·87	2·10	—	1·49					
		400	—	—	7·72	34·58	27·01	2·10	—	2·45					
		610[3]	607	—	5·75	34·43	27·16	2·61	—	2·43					
		800[3]	—	—	4·34	34·38	27·28	2·61	—	2·77					
		1010[2]	1006	—	3·52	34·41	27·39	2·61	—	3·79					
		1200[1]	1200	—	3·19	34·58	27·56	2·10	—	3·99					
		1500[2]	—	—	3·23	34·74	27·68	1·68	—	4·06					
WS 987	21	0	—	—	15·71	34·97	25·82	1·76	—	5·99	**N 70 V**	100–50	1822		
		10	—	—	15·47	35·00	25·89	1·76	—	—	,,	250–100			
		20	—	—	15·20	35·03	25·97	1·51	—	1·26	,,	50–0			
		30	—	—	15·04	35·00	25·98	1·25	—	—	**N 50 V**	100–0	—	**1955**	
		50	—	—	14·52	34·93	26·04	1·51	—	5·10					
		75	—	—	13·97	35·02	26·23	2·92							
		100	—	—	12·75	34·96	26·43	1·68	—	3·59	—	—	—	—	Large stray below 100 m.
		150	—	—	11·71	34·95	26·63	1·59							
		200	—	—	11·11	34·92	26·71	2·10	—	0·80					
WS 988	22	0	—	—	16·26	35·06	25·75	1·08	—	7·89	**N 70 V**	50–0	**0035**		
		10	—	—	14·61	35·07	26·12	1·68	—	—	,,	100–50			
		20	—	—	13·75	35·06	26·30	> 3·50	—	3·61	**N 50 V**	100–0	—	**0115**	P?
		30	—	—	13·34	35·04	26·37	2·36							
		50	—	—	12·25	35·04	26·59	1·42	—	1·48					
		75	—	—	12·07	35·00	26·60	2·49							
		100	—	—	11·92	35·00	26·62	2·49	—	0·34					
		125	—	—	11·80	35·00	26·65	2·88	—	0·25					
WS 989	22	0	—	—	14·82	35·03	26·05	1·42	—	7·06	**N 50 V**	50–0	**0303**		
		10	—	—	14·15	35·03	26·20	1·51	—	—	**N 70 V**	50–0	—	**0322**	
		20	—	—	13·08	35·03	26·42	1·98	—	2·05					
		30	—	—	12·76	35·03	26·48	2·92							
		50	—	—	12·66	35·02	26·50	2·95	—	0·22					
		60	—	—	12·64	35·05	26·51	2·92	—	0·29					
WS 990	22	0	—	—	14·9	—	—	—	—	—	**DC**	128	0905	0915	
		10	—	—	14·7	—	—	—	—	—	**BT**	131–0	0920	0930	
		20	—	—	13·8	—	—	—	—	—	**N 50 V**	100–0	0930	0940	
		30	—	—	13·6	—	—	—	—	—	**OTC**	153–	1000	1228	
		40	—	—	12·7										
		50	—	—	12·6										

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 990 *cont.*	From 25° 35′ S., 14° 27′ E to 25° 36′ S., 14° 24′ E	1950 11 iii												
WS 991	26° 08′ S., 14° 14′ E	11 iii	1635–1652	232*	S	7–10	SSW	2	SSW	2	bc	1014·4	17·8	16·7
WS 992	26° 35′ S., 14° 03′ E	11 iii	2052–2110	398*	S	17–21	S	3	SSW	2	b	1011·0	18·3	17·2
WS 993	27° 03′ S., 13° 55′ E	12 iii	0117–0150	871*	S	11–16	S	3	S	2	b	1013·0	20·0	18·3
WS 994	27° 31′ S., 13° 42′ E	12 iii	0555–0615	—	S · E	11–21	S	3	S	3	b	1011·7	17·2	15·6
WS 995	28° 02′ S., 13° 37′ E	12 iii	1015–1030	—	S	7–10	S	2	S	3	b	1013·0	20·0	18·9
WS 996	From 28° 41′ S., 13° 25′ E	12 iii	1551–	—	SSE	11–21	SSE	3	S	1	b	1013·0	20·0	18·9
	to 28° 39′ S., 13° 23′ E		1955	—	SE	7–10	SE	2	SSE	1	bc	1013·0	20·6	19·4

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O_2 c.c./litre	Gear	Depth (metres)	TIME From	TIME To	
WS 990 *cont.*	22	75	—	—	12·1										
		100	—	—	11·7										
		131	—	—	11·5										
WS 991	22	0	—	—	15·4	—	—	—	—	—	**N 50 V**	100–0	1645	1652	
		10	—	—	14·9	—	—	—	—	—	**BT**	138–0	1646	1652	
		20	—	—	14·1										
		30	—	—	13·7										
		50	—	—	13·2										
		75	—	—	12·9										
		100	—	—	12·2										
		138	—	—	11·2										
WS 992	22	0	—	—	16·4	—	—	—	—	—	**BT**	138–0	2100	2110	
		10	—	—	16·0	—	—	—	—	—	**N 50 V**	100–0	2102	2110	
		20	—	—	15·0										
		30	—	—	14·9										
		50	—	—	14·2										
		75	—	—	13·5										
		100	—	—	13·0										
		138	—	—	12·3										
WS 993	23	0	—	—	20·5	—	—	—	—	—	**BT**	138–0	0125	0135	
		20	—	—	20·5	—	—	—	—	—	**N 50 V**	100–0	0138	0145	
		30	—	—	20·3										
		40	—	—	20·0										
		50	—	—	17·7										
		60	—	—	16·2										
		70	—	—	15·1										
		80	—	—	15·0										
		100	—	—	13·6										
		138	—	—	12·8										
WS 994	23	0	—	—	20·3	—	—	—	—	—	**BT**	138–0	0600	0610	
		40	—	—	20·0	—	—	—	—	—	**N 50 V**	100–0	0602	0610	
		75	—	—	17·7										
		90	—	—	17·0										
		100	—	—	15·9										
		138	—	—	13·3										
WS 995	23	0	—	—	18·4	—	—	—	—	—	**BT**	138–0	1020	1030	
		10	—	—	17·3	—	—	—	—	—	**N 50 V**	100–0	1020	1030	
		20	—	—	16·7										
		30	—	—	16·6										
		50	—	—	16·4										
		75	—	—	13·8										
		100	—	—	12·3										
		138	—	—	11·9										
WS 996	23	0	—	—	20·38	35·18	24·82	0·00	—	5·50	**N 50 V**	100–0	1555	1605	
		10	—	—	20·38	35·17	24·82	0·00	—	—	**N 70 V**	1000–0	1610	—	Net failed to close
	23	20	—	—	19·77	35·18	24·99	0·09	—	5·47	,,	1000–750			
		30	—	—	19·53	35·18	25·05	0·09	—	—	,,	750–500			
		50	—	—	18·58	35·18	25·29	0·08	—	5·67	,,	500–250			
		75	—	—	15·76	35·20	25·50	0·33	—	—	,,	250–100			
		100	—	—	14·11	35·15	26·30	0·25	—	4·87	,,	100–50			
		150	—	—	12·13	34·96	26·55	0·75	—	—	,,	50–0	—	1858	
		200	—	—	11·18	34·86	26·65	0·92	—	4·34					
		300	—	—	9·54	34·69	26·80	—	—	4·75					
		400	—	—	8·04	34·65	27·01	1·42	—	4·56					
		600[2]	602	—	4·99	34·34	27·18	1·68	—	4·53					
		800[2]	—	—	4·14	34·39	27·31	1·85	—	3·26					
		1000[2]	1000	—	3·40	34·45	27·43	1·51	—	3·75					
		1170[1]	1169	—	3·01	34·53	27·53	2·10	—	4·13					
		1470[1]	—	—	3·05	34·70	27·67	1·68	—	4·17					
		2000[1]	1995	—	3·01	34·80	27·75	1·38	—	4·52					

Station	Position	Date	Hour	Sounding (metres)	Wind Direction	Wind Force (knots)	Sea Direction	Sea Force	Swell Direction	Swell Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 997	From 28° 40′ S, 14° 06′ E	1950 13 iii	0030–	1075*	SE	7–10	S	2	S	1	bc	1014·0	19·4	18·9
	to 28° 37′ S, 14° 08′ E		0416	983*	S	7–10	S	2	S	1	bc	1014·0	—	—
WS 998	28° 40′ S, 14° 43′ E	13 iii	0804–0930	198*	S × E	7–10	S	2	S	1	bc	1013·8	18·9	17·8
WS 999	From 28° 38′ S, 14° 59′ E	13 iii	1120–	171* br.S	S × E	7–10	S	2	S	1	o	1014·6	18·3	17·8
	to 28° 31′ S, 15° 00′ E		1543	—	S × E	7–10	SSE	2	SSE	1	o	1015·0	18·9	17·8
WS 1000	28° 40′ S, 15° 29′ E	13 iii	1934–2040	188*	S × E	7–10	SSE	2	SSE	1	o	1014·6	18·9	17·8
WS 1001	28° 40′ S, 15° 56′ E	13–14 iii	2355–0158	121*	SSW	2	S	2	S	1	o	1015·3	17·8	17·2
WS 1002	28° 40′ S, 16° 14′ E	14 iii	0253–0343	69*	Lt airs	—	—	0	SE	1	o	1017·5	17·2	16·7
WS 1003	33° 12′ S, 27° 46′ E	2 v	0815–1400	80* S.Sh	ESE	5	ESE	2	Sly.	2	od	1026·0	16·1	15·6
WS 1004	33° 15′ S, 27° 48′ E	2 v	1700–1723	93*	ESE	7–10	ESE	2	SE	2	od	1024·0	17·2	16·1
	33° 16′ S, 27° 47′ E	3 v	0612–0957	90*	ENE	17–27	SE	3	SE	4	o	1014·0	19·4	18·3
	33° 15′ S, 27° 48′ E	4 v	0955–1225	93*	SW	11–16	SW	4	SW	4	bc	1015·0	17·8	15·6

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O_2 c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 997	24	0	—	—	20·18	35·20	24·89	<0·04	—	4·97	**N 70 V**	1000–0	**0105**	—	Net failed to close
		10	—	—	20·16	35·19	24·88	0·20	—	—	,,	1000–750			
	24	20	—	—	19·39	35·20	25·09	0·29	—	5·35	,,	750–500			
		30	—	—	18·79	35·21	25·26	0·50	—	—	,,	500–250			
		50	—	—	15·71	35·21	26·00	0·50	—	5·15	,,	250–100			
		75	—	—	14·19	35·04	26·20	0·92	—	—	,,	100–50			
		100	—	—	12·83	35·03	26·47	0·67	—	4·98	,,	50–0			
		150	—	—	12·12	34·91	26·52	0·83	—	—	,,	250–0	—	—	Net failed to close
		200	—	—	11·18	34·84	26·64	0·92	—	4·87	**N 50 V**	100–0	—	**0410**	
		300	—	—	9·06	34·63	26·84	1·85	—	4·43					
		400	—	—	7·54	34·61	27·06	1·68	—	3·97					
		570[1]	571	—	5·17	34·31	27·13	2·49	—	4·00					
		780[1]	—	—	4·00	34·34	27·29	2·36	—	3·50					
		880[1]	877	—	3·59	34·46	27·42	2·23	—	3·71					
WS 998	24	0	—	—	18·36	35·01	25·21	0·50	—	5·64	**N 50 V**	100–0	0810		
		10	—	—	18·35	35·01	25·22	0·42	—	—	**N 70 V**	175–100			
		20	—	—	18·33	35·00	25·21	0·42	—	5·72	,,	100–50			
		30	—	—	16·17	34·98	25·72	0·67	—	—	,,	50–0	—	0850	
		50	—	—	14·05	35·03	26·22	0·67	—	4·75					
		75	—	—	12·28	35·01	26·57	1·08							
		100	—	—	11·62	34·94	26·63	1·08	—	4·84					
		150	—	—	10·21	34·84	26·81	1·08	—	4·13					
		175	—	—	9·53	34·76	26·86	1·98	—	3·59					
WS 999	24	0	—	—	18·22	35·00	25·24	0·42	—	5·72	**N 70 V**	150–100	1125		
		10	—	—	18·20	34·91	25·18	0·83	—	—	,,	100–50			
	24	20	—	—	17·23	34·88	25·38	0·50	—	5·77	,,	50–0			
		30	—	—	15·20	35·03	25·97	0·50	—	—	**N 50 V**	100–0	—	1200	
		50	—	—	14·00	35·01	26·22	0·67	—	4·70	**DC**	172	1305	1340	
		75	—	—	11·05	34·84	26·66	0·92	—	—	**OTC**	172–	1350	1540	
		100	—	—	10·59	34·85	26·75	1·42	—	4·16					
		150	—	—	9·48	34·76	26·87	2·49	—	3·47					
WS 1000	24	0	—	—	18·00	34·89	25·21	0·50	—	5·84	**N 70 V**	150–100	**1940**		
		10	—	—	18·00	34·86	25·18	0·50	—	—	,,	100–50			
		20	—	—	17·95	34·82	25·17	0·50	—	5·91	,,	50–0			
		30	—	—	16·08	34·86	25·64	0·75	—	—	**N 50 V**	100–0	—	**2030**	
		50	—	—	11·09	34·87	26·68	1·59	—	3·90					
		75	—	—	10·12	34·76	26·76	1·51							
		100	—	—	9·39	34·61	26·78	1·68	—	3·83					
		150	—	—	8·91	34·61	26·86	2·10	—	2·24					
WS 1001	24–25	0	—	—	17·14	32·39	23·51	0·50	—	7·01	**N 70 V**	100–50	**0005**		
		10	—	—	16·46	34·62	25·38	0·33	—	—	,,	50–0			
		20	—	—	13·26	34·87	26·26	1·98	—	4·14	**N 50 V**	100–0	—	**0140**	
		30	—	—	11·65	34·88	26·58	1·08							
		50	—	—	11·01	34·86	26·68	1·17	—	4·17					
		75	—	—	10·28	34·76	26·73	1·59							
		100	—	—	10·07	34·69	26·71	2·75	—	0·88					
WS 1002	25	0	—	—	14·23	33·64	25·11	0·92	—	6·74	**N 50 V**	60–0	**0302**		
		10	—	—	11·92	34·57	26·29	1·85	—	—	**N 70 V**	50–0	—	**0330**	
		20	—	—	11·04	34·66	26·52	1·34	—	4·07					
		30	—	—	10·43	34·76	26·71	1·85							
		50	—	—	10·08	34·76	26·77	2·49	—	1·70					
WS 1003	15	—	—	—	—	—	—	—	—	—	**DC**	80	0745	0758	
											OTC	80	0810	1400	
WS 1004	15	—	—	—	—	—	—	—	—	—	**LL**	93	1705/2	**0612/3**	Unable to haul either line
	16	—	—	—	—	—	—	—	—	—	—	—	0730/3	0957/3	1st line hauled
	17	—	—	—	—	—	—	—	—	—	—	—	1020/4	1225/4	2nd line hauled

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1005	33° 17′ S, 27° 40′ E (centre position)	1950 5 v	0800– 1540	84* 73*	W Wly	22–27 17–27	WSW WSW	4 4	WSW WSW	4–5 4	b bc	1027·0 1029·0	17·8 18·9	16·7 14·4
WS 1006	33° 14′ S, 27° 36′ E	6–7 v	0920/6 1330/6 0930/7	37* — —	SW × W SW × W NE	17–21 17–21 5	SW × W SW × W WSW	3 3 2	SW SW SW	5 5 4	bc b b	1029·0 1030·0 1030·0	18·3 20·0 18·3	14·4 16·1 16·7
WS 1007	33° 26′ S, 27° 42′ E	7 v	1210– 1400	232*	WSW	5	WSW	1	SW	4	b	1031·0	20·0	17·2
WS 1008	33° 35′ S, 27° 30′ E	7 v	1610– 1720	143*	ENE	5	SW	2	SW	3–4	b	1027·0	22·2	19·4
WS 1009	33° 18′ S, 27° 55′ E	8 v	0825– 0853	164*	NNE	5	NNE	2	SSW	5	bc	1027·0	20·6	17·2
WS 1010	33° 18′ S, 27° 51′ E	9 v	0740– 0905	260*	NNE	7–10	NNE	2	SSW	4	o	1022·0	21·7	19·4
WS 1011	From 33° 19′ S, 27° 46′ E to 33° 28′ S, 27° 34′ E	9 v	1018– 1820	106* br.c.S. Sh	NE × E	11–16	NE × E	2	NE	1	bc	1018·0	21·7	18·3
WS 1012	33° 20′ S, 27° 35′ E	10 v	1245– 1407	82*	Calm	0	—	—	E	2	b	1021·0	18·9	16·7
WS 1013	20° 29′ S, 57° 14′ E	27 vi	1804– 1816	212*	SE	7–10	SE	2	SE	3	c	1019·0	22·8	—
WS 1014	20° 38′ S, 57° 52′ E	27 vi	2345– 2359	—	ESE	4–6	E	2	SE	2	b	1019·0	22·8	22·2
WS 1015	21° 11′ S, 60° 43′ E	28 vi	2000– 2030	—	NNE	4–6	NE	2	NE	5	bc	1021·6	22·8	22·2
WS 1016	21° 41′ S, 64° 10′ E	29 vi	2000– 2015	—	S × E	4–6	E	1	NE	2	bc	1021·6	22·2	22·2
WS 1017	From 22° 18′ S, 67° 29′ E to 22° 23′ S, 67° 26′ E	30 vi– 1 vii	2000– 0520	3542 y.Gl.Oz	ESE	11–16	SW	1	SW	4	bc	1026·8	22·8	22·0

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS						Mg.-atom m.³			BIOLOGICAL OBSERVATIONS		TIME		Remarks
		Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σt	P inorganic	P total	O_2 c.c./litre	Gear	Depth (metres)	From	To	
WS 1005	18	—	—	—	—	—	—	—	—	—	OTC	86	0800	0915	Warps fouled, no catch
	18	—	—	—	—	—	—	—	—	—	,,	84	1150	1540	
WS 1006	19	—	—	—	—	—	—	—	—	—	LL	37	0920/6	1617/6	
	19	—	—	—	—	—	—	—	—	—	TNL	48	1045/6	1715/6	With bait
	20	—	—	—	—	—	—	—	—	—	,,	33	1720/6	0930/7	With bait + under-water lamp
WS 1007	20	—	—	—	—	—	—	—	—	—	OTC	232	1207	1355	Hauled with difficulty—v. strong current
WS 1008	20	—	—	—	—	—	—	—	—	—	TNL	143	1634	—	TNL lost—v. strong current
WS 1009	21	—	—	—	—	—	—	—	—	—	LL	165–128	0825	—	LL lost—v. strong current
WS 1010	22	—	—	—	—	—	—	—	—	—	LS	263–1320	0741	0905	
WS 1011	22	—	—	—	—	—	—	—	—	—	DC	106	1039	1104	
											OTC	102	1110	1340	Trawl fouled, not fishing properly
											,,	110	1710	1820	Trawl fouled, no catch
WS 1012	23	—	—	—	—	—	—	—	—	—	OTC	73	1235	1405	Trawl extensively damaged
WS 1013	11	0	—	—	24·0	—	—	—	—	—	BT	138–0	1809	1815	GMT = zone − 4 hrs
		30	—	—	24·0										
		50	—	—	23·4										
		75	—	—	23·2										
		100	—	—	21·7										
		138	—	—	19·6										
WS 1014	11	0	—	—	23·1	—	—	—	—	—	BT	138–0	2354	2359	
		10	—	—	23·1										
		20	—	—	23·1										
		30	—	—	23·1										
		50	—	—	23·1										
		75	—	—	22·8										
		100	—	—	21·6										
		138	—	—	19·9										
WS 1015	12	0	—	—	23·6	—	—	—	—	—	BT	138–0	2006	2014	
		10	—	—	23·6	—	—	—	—	—	N 50 V	100–0	2020	2026	
		20	—	—	23·5										
		30	—	—	23·4										
		50	—	—	23·2										
		75	—	—	22·9										
		100	—	—	22·0										
		138	—	—	19·6										
WS 1016	13	0	—	—	22·8	—	—	—	—	—	BT	138–0	2002	2009	
		10	—	—	22·7	—	—	—	—	—	N 50 V	100–0	2002	2010	
		20	—	—	22·6										
		30	—	—	22·6										
		50	—	—	22·5										
		75	—	—	22·1										
		100	—	—	19·7										
		138	—	—	18·1										
WS 1017	14	0	—	—	23·34	35·17	23·99	0·25	—	4·89	N 50 V	100–0	2151	—	Great stray on wires; deep catch discarded
		10	—	—	23·34	35·15	23·97	0·17	—	—	N 70 V	1000–750	—	—	
		20	—	—	23·33	35·17	23·99	0·17	—	4·91	,,	50–0	—	2320	
		30	—	—	23·16	35·26	24·11	0·17							
		50	—	—	23·00	35·38	24·25	0·25	—	4·87					
		75	—	—	22·29	35·47	24·52	0·17							

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1017 *cont.*	From 22° 18′ S, 67° 29′ E to 22° 23′ S, 67° 26′ E	1950 30 vi–1 vii												
WS 1018	22° 51′ S, 68° 46′ E	1 vii	2000–2030	—	ESE	17–21	E	3	E	5	ce	1027·0	21·7	21·1
WS 1019	23° 15′ S, 70° 51′ E	2 vii	2004–2028	—	SE × S	17–27	SE	4	SE	5	bc	1024·0	20·6	17·8
WS 1020	25° 16′ S, 72° 55′ E	7 vii	2000–2013	—	SE × S	11–16	SE	3	SE	5	b	1022·0	18·9	18·9
WS 1021	20° 16·5′ S, 57° 21·5′ E Fringing Reef, Flic en Flacq, Mauritius	16 vii	0645–0830	—	Calm	0	SW	1	—	0	b	1022·0	21·1	—
WS 1022	From 25° 26′ S, 46° 07′ E to 25° 27′ S, 46° 10′ E	27 vii	1853–2156	58* S.Sh	NE	11–16	NE	2	NE	5	bc	1023·0	21·1	20·0
WS 1023	25° 56′ S, 45° 29′ E	28 vii	1904–2201	77* y.br.S	S × W	11–16	ESE	3	SE	3	cp	1022·0	20·6	18·3
WS 1024	23° 25′ S, 43° 34′ E	31 vii	2140–2155	—	SW	5	SW	2	SW	3	bc	1021·7	21·7	20·6
WS 1025	22° 40′ S, 41° 39′ E	1–2 viii	1930–0424	3235 gy.br. Gl.Oz	S × W	17–21	SW	2	SSW	3	c	1021·7	22·2	20·0

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O_2 c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 1017 *cont.*	14	100	—	—	21·93	35·46	24·61	0·50	—	4·80					
		150	—	—	21·96	35·36	24·52	0·17							
		200	—	—	20·97	35·51	24·91	0·20	—	4·58					
		300	—	—	15·16	35·49	26·33	0·50	—	4·93					
		400	—	—	12·77	35·21	26·62	0·67	—	5·25					
		580[1]	579	—	10·64	34·85	26·74	1·00	—	4·96					
		970[1]	—	—	5·70	34·42	27·14	1·98	—	3·58					
		1320[2]	—	—	3·58	34·50	27·45	2·10	—	2·69					
		1360[1]	1363	—	3·54	34·59	27·53	2·23	—	2·83					
		1800[2]	1799	—	2·43	34·64	27·67	2·23	—	3·20					
WS 1018	15	0	—	—	22·1	—	—	—	—	—	**BT**	138–0	**2006**	**2013**	
		10	—	—	22·1	—	—	—	—	—	**N 50 V**	100–0	**2018**	**2024**	
		20	—	—	22·1										
		30	—	—	22·1										
		50	—	—	22·2										
		75	—	—	22·1										
		100	—	—	22·0										
		138	—	—	21·8										
WS 1019	16	0	—	—	22·1	—	—	—	—	—	**BT**	138–0	**2009**	**2015**	GMT = zone − 5 hrs
		10	—	—	22·1	—	—	—	—	—	**N 50 V**	100–0	**2015**	**2022**	
		20	—	—	22·2										
		30	—	—	22·2										
		50	—	—	21·9										
		75	—	—	21·7										
		100	—	—	20·1										
		138	—	—	18·7										
WS 1020	21	0	—	—	21·5	—	—	—	—	—	**BT**	138–0	**2007**	**2013**	
		10	—	—	21·6										
		20	—	—	21·6										
		30	—	—	21·6										
		50	—	—	21·6										
		75	—	—	21·5										
		100	—	—	21·4										
		138	—	—	19·3										
WS 1021	1	—	—	—	—	—	—	—	—	—	**Sh. Coll.**	—	0645	0830	Fringing coral reef on volcanic substrate. GMT = zone − 4 hrs
WS 1022	11	—	—	—	—	—	—	—	—	—	**DC**	58	**1855**	**1906**	GMT = zone − 3 hrs
											DLH	66	**1915**	**1937**	
											OTC	66	**2000**	**2030**	Trawl fouled, repeated
											,,	66	**2030**	**2156**	
WS 1023	12	—	—	—	—	—	—	—	—	—	**DC**	77	**1925**	**1933**	No sample, dredge repeated
											,,	77	**1934**	**1942**	
											DLH	77	**1952**	**2016**	
											OTC	77	**2035**	**2201**	
WS 1024	16	0	—	—	23·2	—	—	—	—	—	**N 50 V**	100–0	**2145**	**2152**	
		10	—	—	23·2	—	—	—	—	—	**BT**	135–0	**2146**	**2152**	
		20	—	—	23·2										
		30	—	—	23·2										
		50	—	—	23·0										
		75	—	—	22·2										
		100	—	—	21·8										
		135	—	—	19·5										
WS 1025	17–18	0	—	2·5°	23·62	35·40	24·08	0·00	—	4·93	**N 50 V**	100–0	**2112**	**2119**	
		10	—	10°	23·62	35·28	23·98	0·04	—	—	**N 70 V**	1000–750	**2136**		
		20	—	15°	23·61	35·31	24·01	0·04	—	5·40	,,	750–500	—	—	Haul repeated
		30	—	15°	23·61	35·24	23·96	0·04	—	—	,,	750–500			
		50	—	20°	23·54	35·24	23·98	0·09	—	4·87	,,	500–250			

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1025 *cont.*	22° 40′ S, 41° 39′ E	1950 1–2 viii												
WS 1026	22° 00′ S, 40° 10′ E	2–3 viii	2015–0457	1763?	SE × S	11–16	SSE	2	SSE	3	b	1025·0	22·2	18·9
WS 1027	21° 05′ S, 37° 50′ E	3–4 viii	2330–0640	2957	S	7–10	S	2	SSE	2	b	1023·0	22·2	18·9
WS 1028	20° 42′ S, 37° 03′ E	4 viii	1107–1135	—	SE	22–27	SE	4	SSE	4	bc	1026·0	23·3	19·4
WS 1029	20° 29′ S, 36° 30′ E	4 viii	1505–1513	—	SE	24	SE	4	SSE	4	bc	1026·0	23·3	20·8

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS Depth (metres)	Depth by thermo-meter	Wire angle	Temp. C.	S ‰	σt	Mg.-atom m.³ P inorganic	P total	O₂ c.c. litre	BIOLOGICAL OBSERVATIONS Gear	Depth (metres)	TIME From	To	Remarks
WS 1025 *cont.*	17–18	75	—	25°	22·32	35·26	24·35	0·29	—	—	**N 70 V**	250–100			
		100	—	30°	20·52	35·26	24·84	0·50	—	3·66	,,	100–50			
		150	—	30°	18·06	35·34	25·54	0·50	—	—	,,	50–0	—	**0015**	
		200	—	35°	16·40	35·35	25·94	0·50	—	3·97	**NH**	0			
		300	—	35°	13·82	35·27	26·46	0·58	—	4·71	**N 70 B**				
		400	—	35°	12·66	35·15	26·60	0·67	—	4·80	**N 100 B**	174–0	**0346**	**0404**	KT
		600	—	40°	10·84	34·93	26·77	1·00	—	4·90	**N 100 H**	5–0	**0352**	**0404**	
		750[2]	747		8·35	34·70	27·01	1·51	—	3·36					
		950[2]	—	40°	6·64	34·70	27·26	1·85	—	2·43					
		1470[2]	1465		4·43	34·72	27·54	2·10	—	2·19					
		1820[1]	1821		3·07	34·70	27·67	2·10	—	3·09					
		2300[1]	—	40°	2·52	34·71	27·73	2·10	—	3·63					
		2780[1]	2781		2·21	34·74	27·77	3·14	—	3·81					
WS 1026	18–19	0	—	0°	24·51	35·13	23·61	—	—	4·74	**N 50 V**	100–0	**2149**	**2201**	No sample in Baillie rod
		10	—	5°	24·52	35·11	23·60	0·04	—	—	**N 70 V**	1000–750	**2207**		
		20	—	5°	24·52	35·12	23·60	0·04	—	4·76	,,	750–500			
		30	—	5°	24·51	35·11	23·60	0·09	—	—	,,	500–250	—	**2336**	Net lost
		50	—	5°	24·50	35·16	23·63	0·09	—	4·75	,,	250–100	**0306**		
		75	—	15°	24·49	35·15	23·63	0·09	—	—	,,	100–50			
		100	—	25°	24·47	35·19	23·63	0·42	—	4·78	,,	50–0	—	**0337**	
		150	—	20°	21·11	35·21	24·65	0·42	—	—	,,	500–250	**0342**	**0400**	
		200	—	25°	17·77	35·34	25·61	0·50	—	3·39	**N 100 B**	201–0	**0437**	**0452**	KT
		300	—	30°	14·54	35·26	26·29	0·58	—	4·00	**N 100 H**	5–0	**0439**	**0457**	
		400	—	25°	12·74	35·16	26·58	0·50	—	5·01					
		600	—	30°	9·75	34·77	26·83	0·92	—	4·88					
		1020[1]	1023		5·97	34·65	27·30	1·98	—	2·22					
		1220[1]	—	30°	5·33	34·69	27·40	1·98	—	1·79					
		1520[1]	1516		3·94	34·69	27·56	1·98	—	2·07					
WS 1027	19–20	0	—	5°	23·14	35·27	24·12	0·00	—	4·87	**N 50 V**	100–0	**0021**	**0028**	Lucas wire parted [on hauling
		10	—	5°	23·15	35·26	24·11	0·00	—	—	**N 70 V**	1000–0	**0047**	—	Failed to close
		20	—	8°	23·16	35·25	24·09	0·13	—	4·80	,,	1000–750			
		30	—	10°	23·14	35·28	24·12	0·13	—	—	,,	750–500	—	—	Depth doubtful, [repeated
		50	—	10°	22·03	35·25	24·13	0·20	—	4·03	,,	750–500			
		75	—	15°	20·84	35·30	24·79	0·20	—	—	,,	500–250			
		100	—	15°	19·73	35·34	25·11	0·45	—	3·64	,,	250–100			
		150	—	15°	17·22	35·37	25·77	0·42	—	—	,,	100–50			
		200	—	25°	15·76	35·37	26·11	0·42	—	4·03	,,	50–0	—	—	Machine stopped
		300	—	20°	13·38	35·26	26·54	0·50	—	4·83	,,	50–0	—	**0450**	while hauling; [repeated
		400	—	22°	12·00	35·05	26·64	0·50	—	4·75	**N 100 B**	110–0	**0613**	**0635**	KT
		600	—	—	9·69	34·79	26·86	1·17	—	4·70	**N 70 B**				
		740[2]	744		7·98	34·65	27·02	1·34	—	4·32	**N 100 H**	5–0	**0614**	**0637**	
		940[2]	—	37°	6·56	34·63	27·21	1·85	—	2·09					
		1130[2]	1130		5·58	34·72	27·40	2·10	—	1·75					
		1330[1]	1325		4·23	34·69	27·53	2·10	—	2·30					
		1800[1]	—	35°	2·74	34·68	27·68	1·68	—	3·26					
		2290[1]	2293		2·33	34·74	27·76	1·68	—	3·96					
WS 1028	20	0	—	—	23·4	—	—	—	—	—	**BT**	126–0	1106	1111	
		10	—	—	23·4	—	—	—	—	—	**N 50 V**	100–0	1115	1120	Haul interrupted,
		20	—	—	23·4	—	—	—	—	—	,,	100–0	1128	1132	[repeated
		30	—	—	23·4										
		50	—	—	23·4										
		61	—	—	23·3										
		75	—	—	22·4										
		100	—	—	19·8										
		126	—	—	18·8										
WS 1029	20	0	—	—	23·8	—	—	—	—	—	**N 50 V**	100–0	1505	1512	
		10	—	—	23·8	—	—	—	—	—	**BT**	130–0	1506	1513	
		20	—	—	23·8										
		30	—	—	23·8										
		50	—	—	23·8										
		70	—	—	23·8										
		75	—	—	22·9										

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1029 *cont.*	20° 29′ S, 36° 30′ E	1950 4 viii												
WS 1030	20° 17′ S, 36° 06′ E	4 viii	1809–2012	62 Co	SSE	22–27	SE	4	SSE	4	bc	1024·0	23·3	21·1
WS 1031	From 34° 14′ S, 29° 24′ E	3–4 ix	2045–	4093	NE	24	NE	4	NE	7	b	1014·0	19·4	17·8
	to 34° 20′ S, 29° 15′ E		0455	—	NE	11–16	NE	4	NE	6	c	1013·0	20·0	18·9
WS 1032	33° 59′ S, 28° 53′ E	4 ix	0845–0915	—	NNE	7–10	NNE	2	NE	6	b	1015·5	20·0	18·9
WS 1033	From 33° 49′ S, 28° 42′ E	4 ix	1126–	2893	NW	7–10	NW	2	NE	6	c	1013·3	20·0	18·3
	to 33° 52′ S, 28° 47′ E		1805	—	SW × W	7–10	NE	2	NE	6	bc	1013·0	20·0	19·5
WS 1034	33° 43′ S, 28° 40′ E	4 ix	2030–2041	—	SW	4–6	SW	2	NE	4	b	1013·2	19·4	17·8

Station	Age of moon (days)	Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O₂ c.c. litre	Gear	Depth (metres)	Time From	Time To	Remarks
		HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				
WS 1029 *cont.*	20	100	—	—	20·6										
		130	—	—	17·9										
WS 1030	20	0	—	5°	24·24	35·12	23·68	0·04	—	4·88	**NH**	0	**1830**	**2000**	
		10	—	10°	24·28	35·13	23·67	0·04	—	—	**N 50 V**	50–0	**1845**	**1850**	Net split, catch
		20	—	20°	24·27	35·12	23·67	0·13	—	4·87	**N 70 V**	50–0	**1904**	**1908**	[retained
		30	—	25°	24·22	35·13	23·69	0·13							
		50	—	25°	24·02	35·12	23·74	0·13	—	4·91					[while hauling
WS 1031	20	0	—	0°	19·80	35·44	25·17	0·20	—	5·30	**N 50 V**	100–0	**2132**	**2145**	Lucas wire parted
		10	—	0°	19·81	35·46	25·18	0·17	—	—	**N 70 V**	1000–750	**2204**		GMT = zone − 2 hrs
	20	20	—	5°	19·81	35·46	25·18	0·17	—	5·22	,,	750–500			
		30	—	5°	19·81	35·43	25·15	0·04	—	—	,,	500–250			
		50	—	5°	19·44	35·46	25·28	0·04	—	5·29	,,	250–100			
		75	—	5°	19·12	35·48	25·37	0·04	—	—	,,	100–50			
		100	—	10°	18·53	35·48	25·52	0·04	—	5·12	,,	50–0	—	—	Machine stopped:
		150	—	10°	18·18	35·47	25·61	0·09	—	—	,,	50–0	—	0032	catch discarded,
		200	—	10°	18·21	35·46	25·59	0·09	—	5·03					[repeated
		300	—	15°	17·48	35·52	25·81	0·20	—	4·93	**N 100 H**	5–0	0351	0419	
		400	—	20°	15·30	35·39	26·22	0·20	—	4·51	**N 100 B**	79–0	0356	0415	KT
		600	—	25°	12·98	35·18	26·56	0·20	—	4·40	**N 70 B**				
		790[2]	791		10·92	34·87	26·71	0·63	—	4·59					
		990[2]	—	20°	8·58	34·67	26·95	0·92	—	4·16					
		1480[2]	1482		4·11	34·49	27·39	1·76	—	3·44					
		1970[1]	1968		3·11	34·65	27·61	2·10	—	3·18					
		2450[1]	—	22°	2·60	34·70	27·71	1·00	—	3·90					
		2940[1]	2937		2·39	34·72	27·74	1·00	—	4·34					
WS 1032	21	0	—	—	19·4	—	—	—	—	—	**BT**	138–0	0842	0849	
		10	—	—	19·4	—	—	—	—	—	**N 50 V**	100–0	0845	—	Haul interrupted:
		20	—	—	19·4	—	—	—	—	—	,,	100–0	—	0911	catch discarded,
		30	—	—	19·4										[repeated
		50	—	—	19·0										
		75	—	—	18·9										
		100	—	—	18·8										
		138	—	—	18·1										
WS 1033	21	0	—	0°	20·93	35·36	24·81	0·04	—	5·11	**N 50 V**	100–0	1240	1247	Lucas wire parted
		10	—	0°	20·70	35·36	24·87	0·58	—	—	**N 70 V**	1000–750	1420		while sounding
	21	20	—	0°	20·60	35·37	24·91	0·20	—	5·10	,,	750–500			
		30	—	0°	20·11	35·39	25·05	0·13	—	—	,,	500–250			
		50	—	0°	19·63	35·48	25·24	0·13	—	5·25	,,	250–100	—	—	Messenger fouled:
		75	—	0°	19·27	35·48	25·33	0·25	—	—	,,	250–100			catch discarded,
		100	—	5°	18·93	35·48	25·42	0·25	—	5·14	,,	100–50			[repeated
		150	—	5°	18·54	35·48	25·52	0·25	—	—	,,	50–0	—	1654	
		200	—	10°	17·93	35·43	25·63	0·38	—	4·78					
		300	—	10°	16·38	35·39	25·98	0·38	—	4·69					
		400	—	25°	14·81	35·35	26·30	0·58	—	4·66					
		600	—	20°	12·63	35·14	26·59	0·67	—	4·92					
		820[2]	819		10·27	34·81	26·78	1·08	—	4·17					
		1020[2]	—	10°	7·55	34·54	27·00	1·59	—	3·63					
		1520[2]	1518		3·97	34·54	27·45	2·10	—	2·95					
		2010[1]	2009	—	2·84	34·65	27·64	1·85	—	3·35					
		2540[1]	—	—	2·51	34·73	27·74	1·85	—	3·85					
		3060[1]	3061	—	2·27	34·74	27·77	1·59	—	4·10					
WS 1034	21	0	—	—	20·2	—	—	—	—	—	**BT**	138–0	**2031**	**2038**	
		10	—	—	20·2	—	—	—	—	—	**N 50 V**	100–0	**2036**	**2041**	
		20	—	—	20·0										
		30	—	—	19·9										
		50	—	—	19·9										
		75	—	—	19·9										
		100	—	—	19·4										
		138	—	—	18·7										

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1035	33° 32′ S, 28° 26′ E	1950 5 ix	0603–0700	—	SW	17–21	WSW	3	WSW	4	c	1016·0	18·3	16·1
WS 1036	33° 28′ S, 28° 19′ E	5 ix	0837–0903	—	W	22–27	W	4	W	4	c	1021·3	18·3	16·1
WS 1037	33° 04′ S, 27° 55′ E	5 ix	1900–2005	82*	SW × W	11–21	SW	3	SW	4	od	1024·0	15·0	13·9
WS 1038	33° 08′ S, 27° 59′ E	5 ix	2200–2256	83*	NW	11–16	NW	3	SW	4	c	1027·0	15·0	13·3
WS 1039	33° 12′ S, 28° 03′ E	5–6 ix	2340–0120	150*	W	11–16	NW	3	SW	4	c	1029·2	16·1	15·0
WS 1040	From 33° 15′ S, 28° 05′ E	6 ix	0330–	—	SSW	7–10	SSW	2	SW	4	od	1021·0	15·6	15·0
	to 33° 25′ S, 27° 57′ E		0640	—	Lt airs	2–5	WSW	1	WSW	2	o	1024·0	15·6	15·0
WS 1041	34° 33′ S, 24° 21′ E	7 ix	1200–1251	119*	W	4–6	SW	2	SW	1	b	1024·7	15·6	12·8
WS 1042	34° 41′ S, 22° 27′ E	8 ix	0001–0115	117*	W	7–10	W	2	SW	2	b	1020·0	14·4	13·3

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O_2 c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 1035	22	0	—	—	19·9	—	—	—	—	—	**BT**	134–0	**0615**	**0621**	
		10	—	—	20·0	—	—	—	—	—	**N 50 V**	100–0	0648	0658	
		20	—	—	20·0										
		30	—	—	20·0										
		50	—	—	19·9										
		75	—	—	19·1										
		100	—	—	18·9										
		134	—	—	18·4										
WS 1036	22	0	—	—	20·8	—	—	—	—	—	**N 50 V**	100–0	0838	0845	
		10	—	—	20·8	—	—	—	—	—	**BT**	135–0	0856	0903	
		20	—	—	20·8										
		30	—	—	20·7										
		50	—	—	19·4										
		75	—	—	19·0										
		100	—	—	18·5										
		135	—	—	17·6										
WS 1037	22	0	—	—	14·9	—	—	—	—	—	**N 50 V**	75–0	**1920**	**1925**	Net split: catch lost
		10	—	—	14·9	—	—	—	—	—	**BT**	75–0	**1922**	**1929**	
		20	—	—	14·9	—	—	—	—	—	**N 100 H**	5–0	**1947**	**2002**	
		30	—	—	14·8										
		50	—	—	14·7										
		75	—	—	14·6										
WS 1038	22	0	—	—	18·6	—	—	—	—	—	**BT**	77–0	**2203**	**2210**	
		9	—	—	18·6	—	—	—	—	—	**N 50 V**	75–0	**2211**	**2216**	
		10	—	—	17·7	—	—	—	—	—	**NH**	0	**2212**	**2217**	
		20	—	—	16·3	—	—	—	—	—	**N 100 H**	5–0	**2236**	**2256**	
		30	—	—	15·6										
		50	—	—	15·4										
		77	—	—	15·3										
WS 1039	22	0	—	—	20·3	—	—	—	—	—	**BT**	113–0	**2342**	**2350**	
		10	—	—	20·4	—	—	—	—	—	**N 50 V**	100–0	**2343**	—	No catch: net parted
		20	—	—	20·3	—	—	—	—	—	,,	100–0	—	**0034**	from bucket,
		30	—	—	19·7	—	—	—	—	—	**N 100 H**	5–0	**0053**	**0113**	[repeated
		50	—	—	18·7										
		75	—	—	17·2										
		100	—	—	16·3										
		113	—	—	15·9										
WS 1040	23	0	—	0°	20·72	35·32	24·83	0·04	—	5·15	**N 50 V**	100–0	**0344**	**0401**	
		10	—	0°	20·72	35·32	24·83	0·04	—	—	**N 70 V**	400–250	**0431**		
	23	20	—	0°	20·72	35·34	24·85	0·04	—	5·25	,,	250–100			
		30	—	0°	20·60	35·34	24·88	0·04	—	—	,,	100–50			
		50	—	0°	20·13	35·35	25·02	0·04	—	5·29	,,	50–0	—	**0545**	
		75	—	5°	20·05	35·35	25·04	0·04	—	—	**N 100 H**	5–0	**0615**	0635	
		100	—	0°	17·12	35·37	25·79	0·50	—	4·24					
		150	—	10°	16·14	35·41	26·05	0·42							
		200	—	15°	13·83	35·26	26·44	0·42	—	4·53					
		300	—	10°	12·92	35·17	26·57	0·58	—	4·85					
		400	—	10°	10·47	34·89	26·81	0·67	—	4·85					
WS 1041	24	0	—	—	16·6	—	—	—	—	—	**BT**	111–0	1202	1209	
		10	—	—	16·5	—	—	—	—	—	**N 50 V**	100–0	1212	1217	
		20	—	—	16·4	—	—	—	—	—	**N 100 H**	5–0	1229	1249	
		30	—	—	13·5										
		50	—	—	10·7										
		75	—	—	9·9										
		100	—	—	9·2										
		111	—	—	9·1										
WS 1042	25	0	—	—	16·5	—	—	—	—	—	**BT**	113–0	**0003**	**0010**	Last 15 m. hauled
		10	—	—	16·5	—	—	—	—	—	**N 50 V**	100–0	**0003**	**0019**	[by hand
		20	—	—	16·4	—	—	—	—	—	**N 100 H**	5–0	**0045**	**0105**	

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1042 *cont.*	34° 41′ S, 22° 27′ E	1950 8 ix												
WS 1043	34° 21′ S, 18° 34′ E	19 ix	1305–1407	78*	S	1–3	S	1	SW	2	b	1024·5	14·4	11·7
WS 1044	34° 25′ S, 18° 30′ E	19 ix	1447–1543	88*	SSE	4–6	SSE	1	SW	2	b	1023·0	16·7	13·9
WS 1045	34° 20′ S, 18° 21′ E	19 ix	1705–1742	77*	S × W	4–6	SSE	1	SSW	2	b	1022·0	16·1	13·3
WS 1046	34° 03′ S, 18° 03′ E	19 ix	2040–2132	190*	S	4–6	S	1	SW	2	b	1022·0	15·0	13·9
WS 1047	32° 43′ S, 17° 38′ E	20 ix	0800–0853	227*	SSW	4–6	SSW	1	SSW	2	b	1022·4	15·0	13·9
WS 1048	31° 25′ S, 17° 13′ E	20 ix	2000–2055	216*	S	17–21	S × W	2	S	3	b	1022·0	15·0	13·9
WS 1049	29° 55′ S, 16° 41′ E	21 ix	0800–0820	161*	S × W	17–21	S × W	3	SSW	3	o	1018·3	13·3	12·2

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σ_t	Mg.-atom m.³ P inorganic	P total	O_2 c.c. litre	BIOLOGICAL OBSERVATIONS Gear	Depth (metres)	TIME From	To	Remarks
WS 1042 *cont.*	25	30	—	—	16·4										
		50	—	—	14·5										
		75	—	—	10·5										
		100	—	—	10·0										
		113	—	—	9·8										
WS 1043	7	0	—	—	15·0	—	—	—	—	—	BT	76–0	1308	1313	
		10	—	—	14·4	—	—	—	—	—	N 50 V	75–0	1318	1322	
		20	—	—	14·3	—	—	—	—	—	N 100 H	5–0	1343	1403	
		30	—	—	14·2										
		50	—	—	13·3										
		55	—	—	11·7										
		76	—	—	10·7										
WS 1044	7	0	—	—	15·6	—	—	—	—	—	BT	82–0	1457	1502	
		10	—	—	14·8	—	—	—	—	—	N 50 V	75–0	1458	1502	
		20	—	—	14·7	—	—	—	—	—	N 100 H	5–0	1515	1538	
		30	—	—	14·7										
		50	—	—	13·9										
		60	—	—	12·8										
		72	—	—	12·4										
		75	—	—	11·4										
		82	—	—	10·3										
WS 1045	7	0	—	—	15·6	—	—	—	—	—	N 50 V	70–0	1705	1709	
		10	—	—	14·9	—	—	—	—	—	BT	67–0	1707	1712	Poor trace: repeated
		20	—	—	14·4	—	—	—	—	—	,,	67–0	1713	1719	
		30	—	—	13·8	—	—	—	—	—	N 100 H	5–0	1720	1740	
		50	—	—	12·1										
		61	—	—	11·0										
		67	—	—	10·8										
WS 1046	7	0	—	—	14·0	—	—	—	—	—	BT	138–0	2045	2052	
		10	—	—	12·7	—	—	—	—	—	N 50 V	100–0	2047	2053	
		20	—	—	11·9	—	—	—	—	—	N 100 H	5–0	2111	2131	
		30	—	—	10·5										
		50	—	—	8·9										
		75	—	—	8·1										
		100	—	—	7·6										
		138	—	—	6·6										
WS 1047	8	0	—	—	13·8	—	—	—	—	—	BT	134–0	0806	0813	
		10	—	—	13·6	—	—	—	—	—	N 50 V	100–0	0807	0812	
		20	—	—	12·8	—	—	—	—	—	N 100 H	5–0	0830	0850	
		30	—	—	12·7										
		50	—	—	10·8										
		75	—	—	9·3										
		100	—	—	8·6										
		134	—	—	7·7										
WS 1048	8	0	—	—	14·9	—	—	—	—	—	BT	132–0	2005	2011	
		10	—	—	14·9	—	—	—	—	—	N 50 V	100–0	2009	2016	
		20	—	—	14·9	—	—	—	—	—	N 100 H	5–0	2033	2053	
		30	—	—	14·9										
		43	—	—	14·7										
		50	—	—	13·9										
		60	—	—	13·3										
		75	—	—	11·6										
		100	—	—	10·4										
		132	—	—	9·2										
WS 1049	9	0	—	—	12·2	—	—	—	—	—	BT	138–0	0811	0817	
		10	—	—	12·2										
		20	—	—	12·2										
		30	—	—	12·2										
		50	—	—	11·1										

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1049 *cont.*	29° 55′ S, 16° 41′ E	1950 21 ix												
WS 1050	28° 39′ S, 16° 15′ E	21 ix	1847–2011	73*	Lt airs	2–5	SW	1	SW	3	b	1016·0	12·8	12·2
WS 1051	28° 40′ S, 15° 56′ E	21–22 ix	2220–0045	128 d.gn.M	Lt airs	2–5	SW	1	SW	3	b	1019·5	12·8	12·2
WS 1052	28° 39′ S, 15° 29·5′ E	22 ix	0741–0955	172 gn.br. M.sk. bl	SSE	5–9	SW	1	SW	2	o	1018·0	13·9	13·3
WS 1053	28° 40′ S, 14° 59′ E	22 ix	1347–1619	177 gn.br.M	S	17–21	S	3	S	4	b	1018·0	15·0	13·9
WS 1054	28° 40′ S, 14° 42′ E	22 ix	1816–2035	199 y.br.M	S	17–21	S	3	S	4	o	1016·0	14·4	13·9
WS 1055	28° 39′ S, 14° 07′ E	23 ix	0910–1403	902 gn.gy. Gl.Oz	SSE	11–16	SSE	1	SSE	3	o	1018·0	13·9	12·8
WS 1056	28° 41′ S, 13° 25′ E	23–24 ix	1922–0210	2586 lt.y.gy. Gl.Oz	S	4–6	S × E	1	Sly	1	o	1016·0	15·0	12·8

Station	Age of moon (days)	Hydrological observations: Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³: P inorganic	P total	O_2 c.c. litre	Biological observations: Gear	Depth (metres)	Time: From	To	Remarks
WS 1049 *cont.*	9	75	—	—	9·3										
		100	—	—	8·9										
		138	—	—	8·2										
WS 1050	9	0	—	0°	11·69	33·91	25·82	2·10	—	4·25	N 50 V	60–0	1857	1900	
		10	—	0°	10·39	34·54	26·55	2·10	—	—	N 70 V	50–0	1912	1915	
		20	—	0°	10·09	34·64	26·68	2·17	—	2·70	N 100 H	5–0	1949	2009	
		30	—	0°	9·79	34·70	26·78	2·17							
		50	—	0°	9·39	34·67	26·82	2·88	—	2·12					
		70	—	5°	9·37	34·68	26·83	2·23	—	0·92					
WS 1051	9	0	—	0°	11·89	34·60	26·31	0·92	—	6·17	N 50 V	100–0	2232	2237	
		10	—	0°	11·81	34·60	26·33	0·92	—	—	N 70 V	100–50	2300		
		20	—	0°	11·81	34·65	26·37	0·92	—	5·55	,,	50–0	—	2320	
		30	—	0°	11·62	34·79	26·52	1·00	—	—	N 100 H	5–0	0024	0044	
		50	—	10°	11·03	34·76	26·60	1·85	—	4·02					
		75	—	10°	9·33	34·76	26·89	2·36							
		100	—	10°	9·31	34·76	26·90	2·61	—	1·11					
		125	—	15°	9·27	34·79	26·93	2·36	—	1·10					
WS 1052	10	0	—	0°	13·58	34·88	26·20	0·42	—	6·10	N 50 V	100–0	0759	0804	
		10	—	0°	13·58	34·88	26·20	0·42	—	—	N 70 V	150–100	0816		
		20	—	5°	13·57	34·88	26·20	0·50	—	6·17	,,	100–50			
		30	—	8°	13·43	34·90	26·25	0·42	—	—	,,	50–0	—	0848	
		50	—	10°	13·08	34·89	26·31	0·50	—	5·92	N 100 B	155–0	0926	0951	KT
		75	—	16°	11·42	34·88	26·62	1·08	—	—	N 70 B				
		100	—	18°	9·82	34·72	26·78	1·42	—	4·05	N 100 H	5–0	0931	0953	
		150	—	25°	8·71	34·54	26·83	2·10	—	2·75					
		170	—	30°	8·62	34·56	26·85	1·98	—	3·04					
WS 1053	10	0	—	5°	14·10	34·91	26·12	0·13	—	6·08	N 50 V	100–0	1410	1418	
		10	—	5°	14·13	34·91	26·11	0·13	—	—	N 70 V	150–100	1431		
		20	—	5°	13·84	34·91	26·17	0·25	—	6·02	,,	100–50			
		30	—	10°	13·70	34·93	26·21	0·25	—	—	,,	50–0	—	1509	
		50	—	10°	13·53	34·93	26·25	0·42	—	5·80	N 100 B	174–0	1555	1616	KT
		75	—	15°	13·34	34·94	26·30	0·42	—	—	N 70 B				
		100	—	15°	11·64	34·88	26·58	0·67	—	4·65	N 100 H	5–0	1605	1617	
		150	—	20°	8·93	34·63	26·86	1·85	—	2·91					
		175	—	25°	8·88	34·69	26·91	1·85	—	2·81					
WS 1054	10	0	—	5°	13·99	34·96	26·17	0·42	—	6·13	N 50 V	100–0	1841	1850	
		10	—	10°	13·98	34·97	26·19	0·20	—	—	N 70 V	175–100	1858	—	Did not fish pro- [perly: repeated
		20	—	15°	13·83	34·97	26·22	0·25	—	6·03	,,	175–100			
		30	—	15°	13·73	34·96	26·23	0·29	—	—	,,	100–50			
		50	—	20°	13·32	34·97	26·33	0·33	—	5·62	,,	50–0	—	1948	
		75	—	25°	10·77	34·90	26·76	1·08	—	—	N 100 H	5–0	2013	2033	
		100	—	25°	10·17	34·83	26·81	1·08	—	4·09					
		150	—	25°	9·24	34·70	26·87	1·68	—	3·14					
		190	—	25°	9·13	34·70	26·89	1·85	—	3·12					
WS 1055	11	0	—	0°	14·80	35·15	26·15	0·29	—	6·11	N 50 V	100–0	0957	1003	
		10	—	0°	14·80	35·15	26·15	0·29	—	—	N 70 V	750–500	1023		
		20	—	5°	14·79	35·15	26·15	0·42	—	5·90	,,	500–250			
		30	—	8°	14·78	35·16	26·16	0·25	—	—	,,	250–100			
		50	—	10°	14·62	35·16	26·19	0·33	—	5·84	,,	100–50	—	—	Did not fish: [repeated
		75	—	11°	13·94	35·10	26·30	0·50	—	—	,,	100–50			
		100	—	13°	13·42	35·04	26·36	0·83	—	5·03	,,	50–0	—	1204	
		150	—	15°	12·01	34·94	26·56	0·83	—	—	N 100 B	141–0	1331	1352	KT
		200	—	17°	10·92	34·88	26·71	1·08	—	4·57	N 70 B				
		300	—	23°	8·72	34·65	26·90	1·34	—	4·55	N 100 H	5–0	1340	1400	
		400	—	30°	6·94	34·49	27·04	1·98	—	4·05					
		540[1]	543	—	5·34	34·40	27·18	1·98	—	3·60					
		720[1]	723	—	4·67	34·38	27·25	2·23	—	2·98					
WS 1056	11	0	—	0°	15·16	35·17	26·09	<0·04	—	5·96	N 50 V	100–0	2030	2042	
		10	—	0°	15·16	35·30?	26·19?	<0·04	—	—	N 70 V	1000–750	2050	—	Net did not fish pro- [perly: repeated

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Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1056 *cont.*	28° 41′ S, 13° 25′ E	1950 23–24 ix												
WS 1057	28° 02′ S, 13° 37′ E	24 ix	1715–1816	—	WSW	4–6	S	1	S	1	bc	1014·0	15·6	12·2
WS 1058	27° 33′ S, 13° 48′ E	24 ix	2205–2252	—	Lt airs	0–3	—	0	S	1	bc	1017·0	14·4	12·8
WS 1059	27° 14′ S, 14° 00′ E	25 ix	0135–0230	860*	Calm	0	—	0	S	1	o	1017·0	14·4	11·7
WS 1060	26° 50′ S, 14° 15′ E	25 ix	0545–0640	388*	Calm	0	—	0	—	0	oz	1016·0	14·4	11·7
WS 1061	26° 25′ S, 14° 32′ E	25 ix	1030–1115	309*	E	1–3	E	1	S	2	c	1018·0	14·4	12·2
WS 1062	25° 35′ S, 14° 27′ E	25 ix	1750–1844	166*	WSW	4–6	—	0	S	2	bc	1014·0	14·4	12·2

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O₂ c.c. litre	Gear	Depth (metres)	TIME From	TIME To	
WS 1056 *cont.*	11	20	—	0°	15·13	35·17	26·10	<0·04	—	5·89	N 70 V	1000–750			
		30	—	0°	15·10	35·19	26·11	<0·04	—	—	,,	750–500			
		50	—	0°	15·04	35·19	26·13	0·17	—	5·80	,,	500–250			
		75	—	0°	14·41	35·14	26·23	0·20	—	—	,,	250–100			
		100	—	0°	13·84	35·05	26·27	0·20	—	5·36	,,	100–50			
		150	—	0°	12·33	35·04	26·58	0·83	—	—	,,	50–0	—	0000	
		200	—	0°	10·89	34·83	26·68	0·92	—	4·66	NH	0	2350	0040	
		300	—	5°	8·86	34·65	26·88	1·42	—	4·31	N 100 B	151–0	0141	0200	KT
		400	—	5°	6·68	34·51	27·10	1·85	—	3·65	N 70 B				
		600	—	5°	4·68	34·33	27·20	1·85	—	4·20	N 100 H	5–0	0145	0205	
		820[2]	817		3·79	34·47	27·41	2·23	—	3·48					
		1030[2]	—	5°	3·45	34·43	27·41	2·23	—	3·15					
		1240[2]	1243		3·18	34·52	27·51	2·23	—	3·52					
		1540[1]	1535		3·12	34·67	27·63	1·91	—	4·11					
		2060[1]	—	10°	3·00	34·81	27·76	1·59	—	4·46					
		2580[1]	2578		2·71	34·81	27·79	1·59	—	4·79					
WS 1057	12	0	—	—	15·5	—	—	—	—	—	BT	138–0	1720	1726	
		10	—	—	15·3	—	—	—	—	—	N 50 V	100–0	1723	1728	
		20	—	—	15·2	—	—	—	—	—	NH	0	1730	1805	
		30	—	—	15·2	—	—	—	—	—	N 100 H	5–0	1745	1805	
		50	—	—	15·2										
		75	—	—	14·9										
		100	—	—	14·9										
		138	—	—	13·8										
WS 1058	12	0	—	—	15·1	—	—	—	—	—	BT	131–0	2210	2218	
		10	—	—	15·0	—	—	—	—	—	N 50 V	100–0	2212	2218	
		20	—	—	15·0	—	—	—	—	—	NH	0	2219	2230	
		30	—	—	15·0	—	—	—	—	—	N 100 H	5–0	2232	2252	
		50	—	—	15·0										
		75	—	—	15·0										
		100	—	—	14·9										
		131	—	—	13·7										
WS 1059	13	0	—	—	14·9	—	—	—	—	—	N 50 V	100–0	0135	0142	
		10	—	—	15·0	—	—	—	—	—	BT	135–0	0136	0143	
		20	—	—	14·9	—	—	—	—	—	N 100 H	5–0	0209	0229	
		30	—	—	14·9										
		50	—	—	14·9										
		75	—	—	14·8										
		100	—	—	13·9										
		138	—	—	12·7										
WS 1060	13	0	—	—	13·4	—	—	—	—	—	BT	133–0	0553	0559	
		10	—	—	13·4	—	—	—	—	—	N 50 V	100–0	0558	0603	
		20	—	—	13·2	—	—	—	—	—	N 100 H	5–0	0615	0635	
		30	—	—	12·9										
		50	—	—	12·8										
		75	—	—	12·6										
		100	—	—	12·2										
		133	—	—	11·1										
WS 1061	13	0	—	—	13·6	—	—	—	—	—	N 50 V	100–0	1035	1041	
		10	—	—	13·4	—	—	—	—	—	BT	119–0	1036	1043	
		20	—	—	11·9	—	—	—	—	—	N 100 H	5–0	1051	1111	
		30	—	—	11·8										
		50	—	—	11·6										
		75	—	—	11·4										
		100	—	—	11·5										
		107	—	—	11·6										
		110	—	—	11·3										
		119	—	—	11·3										
WS 1062	13	0	—	—	13·3	—	—	—	—	—	N 50 V	100–0	1754	1800	
		10	—	—	12·2	—	—	—	—	—	BT	138–0	1755	1802	

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1062 *cont.*	25° 35′ S, 14° 27′ E	1950 25 ix												
WS 1063	25° 11′ S, 14° 39′ E	25 ix	2150–2353	69 R?	SW	4–6	SW	2	W	2	b	1018·0	12·2	10·6
WS 1064	25° 12′ S, 14° 22′ E	26 ix	0900–1240	139 d.gn.M. H_2S	SW	7–10	SW	2	WSW	2	b	1017·0	12·8	12·2
WS 1065	24° 56′ S, 14° 28′ E	26 ix	1440–1453	106 d.gn.M. H_2S	S	11–16	S	2	SW	2	b	1016·0	14·4	11·7
WS 1066	24° 41′ S, 14° 30′ E	26 ix	1743–1751	35 d.gn.S	SSW	7–10	SW	1	SSW	2	b	1015·5	13·4	12·8
WS 1067	24° 45′ S, 14° 27′ E	26 ix	1836–1911	101 h	SSW	7–10	SW	1	SSW	2	b	1016·0	13·3	12·2
WS 1068	25° 12′ S, 14° 03′ E	26 ix	2330–2359	198 bl.gn. M & Sh	SSW	7–10	SW	1	SW	2	b	1018·0	13·3	12·2
WS 1069	25° 11′ S, 13° 47′ E	27 ix	0739–1127	236 gn.bl. S & Sh	S	11–16	S	1	S	2	b	1018·0	13·9	13·3
WS 1070	From 25° 15′ S, 13° 06′ E	27 ix	1750–	1785 gn.gy.	S	17–21	S	1	S	3	bc	1018·5	15·0	13·3
	to 25° 10′ S, 13° 06′ E		2318	Gl.Oz	S	7–10	S	2	S	3	b	1020·5	13·9	12·8

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σ_t	Mg.-atom m.³ P inorganic	Mg.-atom m.³ P total	O_2 c.c./litre	Gear	Depth (metres)	TIME From	TIME To	
WS 1062 *cont.*	13	20	—	—	12·2	—	—	—	—	—	NH	0	1755	1815	
		30	—	—	11·6	—	—	—	—	—	N 100 H	5–0	1820	1840	
		50	—	—	11·1										
		61	—	—	11·0										
		75	—	—	11·1										
		100	—	—	10·4										
		138	—	—	9·7										
WS 1063	13	0	—	0°	11·14	34·76	26·58	1·42	—	5·20	N 50 V	50–0	**2213**	**2216**	
		10	—	0	10·49	34·76	26·70	1·68	—	—	N 70 V	50–0	**2227**	**2231**	
		20	—	0°	10·42	34·76	26·71	1·68	—	4·24	N 100 H	5–0	**2330**	**2350**	
		30	—	5°	10·24	34·76	26·74	1·98							
		50	—	8°	9·73	34·74	26·82	2·23	—	1·28					
		65	—	8°	9·68	34·74	26·83	2·23	—	0·79					
WS 1064	14	0	—	0°	11·69	34·78	26·50	1·08	—	5·72	NH	0	0930	1130	
		10	—	0°	11·43	34·78	26·54	1·08	—	—	N 50 V	100–0	1016	1021	
		20	—	0°	10·97	34·79	26·64	1·25	—	5·38	N 70 V	100–50	1031		
		30	—	0°	10·77	34·76	26·65	1·42	—	—	,,	50–0	—	1058	
		50	—	0°	10·60	34·78	26·70	1·68	—	4·63	N 100 B	101–0	1211	1230	KT
		75	—	0°	10·46	34·79	26·73	1·68	—	—	N 70 B				
		100	—	0	9·96	34·79	26·72	1·98	—	1·91	N 100 H	5–0	1219	1239	
		135	—	5°	9·63	34·79	26·87	1·85	—	0·43					
		137	—	—	9·62	—	—	1·85	—	—	—	—	—	—	No H_2S present
WS 1065	14	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1066	14	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1067	14	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1068	14	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1069	15	0	—	0°	13·46	34·92	26·25	0·67	—	6·05	NH	0	—	—	While ship lying to
		10	—	0°	13·30	34·94	26·30	0·67	—	—	N 50 V	100–0	0917	0924	[prior to Station
		20	—	7°	13·01	34·94	26·36	0·58	—	5·88	N 70 V	250–100	0934	—	Drifted to deeper
		30	—	10°	12·72	34·92	26·40	0·58	—	—	,,	100–50			[water, > 250 m.
		50	—	15°	12·73	34·92	26·40	0·83	—	5·59	,,	50–0	—	1004	
		75	—	15°	12·20	34·92	26·50	1·00	—	—	N 100 B	201–0	1052	1123	KT
		100	—	20°	11·71	34·89	26·58	1·17	—	3·92	N 70 B				
		150	—	25°	10·58	34·83	26·74	1·85	—	—	N 100 H	5–0	1103	1124	
		200	—	35°	10·27	34·81	26·78	1·85	—	2·07					
WS 1070	15	0	—	0°	13·80	34·94	26·20	0·67	—	6·00	NH	0	1820	1828	
		10	—	0°	13·83	34·96	26·20	0·58	—	—	N 50 V	100–0	1829	1835	
	15	20	—	5°	13·80	34·96	26·21	0·50	—	6·04	N 70 V	1000–750	1847	—	Haul repeated
		30	—	10°	13·80	34·96	26·21	0·58	—	—	,,	1000–750			
		50	—	10°	13·27	34·96	26·32	0·58	—	5·28	,,	750–500			
		75	—	10°	12·70	34·97	26·45	0·67	—	—	,,	500–250			
		100	—	15°	12·20	34·97	26·55	0·58	—	4·69	,,	250–100			
		150	—	20°	11·39	34·92	26·66	0·92	—	—	,,	100–50			
		200	—	20°	10·52	34·87	26·78	1·68	—	2·78	,,	50–0	—	**2117**	
		300	—	25°	9·02	34·69	26·89	1·85	—	2·17	N 100 B	183–0	**2247**	**2315**	KT
		400	—	30°	7·70	34·63	27·05	2·23	—	1·89	N 70 B				
		600[2]	602	15°	5·44	34·42	27·18	2·23	—	2·36	N 100 H	5–0	**2253**	**2316**	
		820[2]	824		4·40	34·42	27·29	2·23	—	3·16					
		990[1]	991	25°	3·76	34·43	27·38	2·10	—	3·34					
		1200[1]	—		3·43	34·52	27·48	1·98	—	3·57					
		1510[1]	1511		3·25	34·67	27·62	1·85	—	4·20					

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1071	24° 50′ S, 13° 19′ E	1950 28 ix	0250–0355	—	S × E	17–21	S × E	3	S	3	b	1018·0	14·0	12·8
WS 1072	24° 20′ S, 13° 38′ E	28 ix	0810–0910	327*	SSW	11–16	SSW	3	SW	3	b	1017·0	13·9	12·8
WS 1073	23° 50′ S, 13° 57′ E	28 ix	1333–1418	201*	S	7–10	S	2	S	1	b	1017·0	14·4	13·3
WS 1074	23° 22′ S, 14° 11′ E	28 ix	1905–2020	115 d.gn.M. H_2S	S	7–10	S	1	S	2	b	1015·7	13·3	12·2
WS 1075	22° 44′ S, 14° 21′ E	29 ix	0644–0903	66 gn.gy.bl. M. H_2S	SSE	7–10	S	1	S	1	bc	1016·8	10·6	10·0
WS 1076	22° 52′ S, 14° 20′ E	29 ix	1033–1237	69 d.gn.M. H_2S	Lt airs	0–2	—	0	S	1	b	1018·4	13·9	12·2
WS 1077	22° 44′ S, 14° 08′ E	29 ix	1428–1636	108 d.gn.M. H_2S	SW	7–10	SW	2	SW	1	b	1017·0	13·9	12·2
WS 1078	22° 46′ S, 13° 35′ E	29 ix	2025–2315	139 d.br. M & Sh	S	11–16	S	3	S	1	b	1017·4	13·9	12·2

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m⁻³ P inorganic	P total	O_2 c.c./litre	Gear	Depth (metres)	TIME From	To	
WS 1071	16	0	—	—	14·5	—	—	—	—	—	**BT**	138–0	**0253**	**0300**	
		10	—	—	14·5	—	—	—	—	—	**N 50 V**	100–0	**0300**	**0307**	
		20	—	—	14·2	—	—	—	—	—	**N 100 H**	5–0	**0331**	**0351**	
		30	—	—	13·6										
		50	—	—	13·3										
		75	—	—	12·8										
		100	—	—	12·5										
		138	—	—	11·6										
WS 1072	16	0	—	—	13·7	—	—	—	—	—	**BT**	138–0	0821	0826	
		10	—	—	13·7	—	—	—	—	—	**N 50 V**	100–0	0823	0829	
		20	—	—	13·7	—	—	—	—	—	**N 100 H**	5–0	0850	0909	
		30	—	—	13·7										
		50	—	—	13·2										
		75	—	—	12·9										
		100	—	—	12·1										
		138	—	—	11·3										
WS 1073	16	0	—	—	13·1	—	—	—	—	—	**BT**	138–0	1333	1340	
		10	—	—	12·7	—	—	—	—	—	**N 50 V**	100–0	1338	1344	
		20	—	—	12·7	—	—	—	—	—	**N 100 H**	5–0	1355	1415	
		30	—	—	12·7										
		37	—	—	11·9										
		50	—	—	11·7										
		75	—	—	11·5										
		100	—	—	11·1										
		138	—	—	10·2										
WS 1074	16	0	—	—	12·1	—	—	—	—	—	**BT**	113–0	**1930**	**1937**	
		10	—	—	12·1	—	—	—	—	—	**N 50 V**	100–0	**1930**	**1939**	
		20	—	—	11·9	—	—	—	—	—	**N 100 H**	5–0	**1958**	**2018**	
		30	—	—	11·8										
		50	—	—	11·3										
		75	—	—	10·8										
		100	—	—	10·7										
		113	—	—	10·7										
WS 1075	17	0	—	0°	11·42	34·84	26·59	2·23	—	2·73	**N 50 V**	55–0	0705	0709	
		10	—	0°	11·41	34·86	26·61	2·10	—	—	**N 70 V**	50–0	0717	0721	
		20	—	0°	11·43	34·86	26·60	2·23	—	2·64	**N 100 H**	5–0	0842	0902	
		30	—	0°	11·42	34·87	26·61	2·23							
		50	—	0°	11·08	34·88	26·69	2·36	—	0·51					
		60	—	0°	10·91	34·88	26·72	2·98	—	0·09	—	—	—	—	No H_2S present at 60 m.
		64	—	0°	10·90	—	—	2·75	—	0·03	—	—	—	—	H_2S present at 64 m.
WS 1076	17	0	—	0°	11·93	34·86	26·51	2·10	—	3·51	**N 50 V**	50–0	1047	1052	
		10	—	0°	11·53	34·86	26·58	2·10	—	3·19	**NH**	0	1100	1130	
		20	—	0°	11·49	34·86	26·59	2·16	—	2·91	**N 70 V**	50–0	1107	1110	
		30	—	0°	11·46	34·87	26·61	2·16	—	2·86	**N 100 H**	5–0	1215	1235	
		40	—	0°	11·09	34·86	26·67	2·23	—	1·81					
		50	—	0°	11·01	34·87	26·69	2·23	—	1·68					
		60	—	0°	11·05	34·88	26·69	2·61	—	0·21	—	—	—	—	No H_2S present at 60 m.
		64	—	0°	10·99	34·87	26·69	2·61	—	0·06	—	—	—	—	H_2S present at 64 m.
WS 1077	17	0	—	0°	13·08	34·86	26·28	1·00	—	5·60	**N 50 V**	100–0	1441	1448	
		10	—	0°	12·33	34·87	26·44	1·00	—	—	**N 70 V**	100–50	1458		
		20	—	0°	12·28	34·87	26·45	1·34	—	5·05	,,	50–0	—	1513	
		30	—	5°	12·24	34·87	26·46	0·92	—	—	**N 100 B**	} 113–0	1610	1629	KT
		50	—	5°	11·47	34·87	26·61	1·59	—	2·41	**N 70 B**				
		75	—	10°	10·99	34·88	26·70	2·10	—	—	**N 100 H**	5–0	1615	1635	
		100	—	10°	11·00	34·97	26·78	2·75	—	0·10					
		107	—	10°	10·95	34·97	26·79	2·75	—	0·03	—	—	—	—	No H_2S present
WS 1078	17	0	—	5°	13·39	34·96	26·30	0·50	—	6·15	**N 50 V**	100–0	**2107**	**2116**	
		10	—	5°	13·40	34·96	26·29	0·50	—	—	**N 70 V**	100–50	**2128**		
		20	—	10°	13·33	34·96	26·31	1·00	—	6·05	,,	50–0	—	**2145**	

Station	Position	Date	Hour	Sounding (metres)	WIND Direction	WIND Force (knots)	SEA Direction	SEA Force	SWELL Direction	SWELL Force	Weather	Barometer (millibars)	Air Temp. °C. Dry bulb	Air Temp. °C. Wet bulb
WS 1078 *cont.*	22° 46′ S, 13° 35′ E	1950 29 ix												
WS 1079	22° 26′ S, 12° 43′ E	30 ix	0730–1150	631 gy.gn.M. sk.bl	SE	22–27	S	3	SE	6	bc	1018·2	13·9	11·1
WS 1080	From 22° 51′ S, 11° 41′ E	2 x	1515–	3155 lt.gy.Gl.	SSE	17–21	SSE	3	SSE	6	b	1019·0	15·6	13·9
	to 22° 43′ S, 11° 37′ E		2248	Oz	SSE	17–21	S	2	SSE	6	bc	1016·5	15·6	14·4
WS 1081	22° 45′ S, 12° 25′ E	3 x	1130–	1970 gy.Gl.	S	4–6	S	2	SSW	1	b	1017·5	16·7	15·0
			1812	Oz	S	4–6	S	1–2	SSW	2	b	1014·3	16·1	15·0
WS 1082	22° 06′ S, 13° 56′ E	6 x	2025–2050	69 d.gn.M. H_2S	NNW	17–21	NNW	3	—	0	fe	1017·0	13·9	13·3
WS 1083	21° 50′ S, 13° 45′ E	6–7 x	2348–0020	69 d.gn.M. H_2S	NNW	11–16	NNW	3	NNW	1	o	1018·2	13·9	13·9
WS 1084	21° 33′ S, 13° 35′ E	7 x	0319–0327	91 d.gn.M. H_2S	NW × N	7–10	NW	2	NNW	1	om	1018·0	14·4	13·9

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS									BIOLOGICAL OBSERVATIONS				Remarks
		Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg-atom m.³		O_2 c.c. litre	Gear	Depth (metres)	TIME		
								P inorganic	P total				From	To	
WS 1078 *cont.*	17	30	—	15°	13·03	34·93	26·35	0·92	—	—	**N 100 B**	155–0	**2238**	**2301**	Nets on bottom: no catch. KT
		50	—	20	12·77	34·91	26·39	0·58	—	5·37	**N 70 B**				
		75	—	20	12·23	34·88	26·47	1·34	—	—	**N 100 H**	5–0	**2245**	**2305**	
		100	—	35°	12·07	34·96	26·56	1·68	—	4·47					
		135	—	35	11·24	34·97	26·73	1·85	—	1·14					
WS 1079	18	0	—	10	15·09	35·17	26·11	0·83	—	5·72	**N 50 V**	100–0	0849	0858	
		10	—	15	15·09	35·16	26·09	0·92	—	—	**N 70 V**	500–250	0911		
		20	—	15	15·08	35·17	26·11	1·59	—	5·76	,,	250–100			
		30	—	15	15·03	35·17	26·12	0·92	—	—	,,	100–50			
		50	—	20°	15·01	35·17	26·13	1·08	—	5·72	,,	50–0	—	1011	
		75	—	28°	13·63	35·12	26·37	1·17	—	—	**N 100 H**	5–0	1128	1148	
		100	—	40°	12·92	35·07	26·48	1·17	—	4·18					
		150	—	35°	12·25	35·04	26·59	1·68	—	—					
		200	—	35°	11·41	34·94	26·67	1·98	—	2·73					
		300	—	35°	9·88	34·81	26·85	2·23	—	1·37					
		400	—	40°	8·47	34·71	27·00	2·61	—	0·68					
		600	—	50	7·19	34·58	27·08	2·36	—	1·23					
WS 1080	20	0	—	0°	15·24	35·13	26·04	0·58	—	5·75	**N 50 V**	100–0	1607	1614	
		10	—	5°	15·24	35·14	26·05	0·42	—	—	**N 70 V**	1000–750	1627		
	20	20	—	10°	15·24	35·12	26·03	0·20	—	5·74	,,	750–500			
		30	—	10°	15·08	35·12	26·06	0·20	—	—	,,	500–250			
		50	—	10°	15·05	35·12	26·07	0·33	—	5·73	,,	250–100			
		75	—	15°	15·02	35·13	26·08	0·42	—	—	,,	100–50			
		100	—	25°	13·14	35·04	26·41	0·42	—	4·52	,,	50–0	—	1810	
		150	—	30°	12·07	34·97	26·58	0·58	—	—	**N 100 B**	170–0	**2214**	**2243**	KT
		200	—	40°	11·25	34·89	26·66	0·58	—	2·70	**N 70 B**				
		300	—	40°	9·50	34·70	26·83	1·17	—	2·43	**N 100 H**	5–0	**2224**	**2245**	
		400	—	45°	8·11	34·60	26·96	1·51	—	1·72					
		600	—	50°	6·00	34·43	27·13	1·76	—	2·20					
		780^{2}	781		4·56	34·38	27·26	2·23	—	2·80					
		990^{2}	—	25°	3·84	34·42	27·35	1·68	—	3·26					
		1500^{2}	1502		3·33	34·70	27·64	1·68	—	4·25					
		1910^{1}	1905		3·25	34·79	27·72	1·08	—	4·52					
		2420^{1}	—	40°	2·93	34·80	27·76	0·92	—	4·61					
		2940^{1}	2944		2·61	34·81	27·80	1·25	—	4·94					
WS 1081	21	0	—	0°	15·61	35·16	25·97	0·67	—	5·85	**N 50 V**	100–0	1211	1217	
		10	—	0°	15·10	35·14	26·08	0·67	—	—	**N 70 V**	1000–750	1307		
	21	20	—	0°	15·05	35·15	26·10	0·50	—	5·80	,,	750–500			
		30	—	0°	15·03	35·17	26·12	0·75	—	—	,,	500–250			
		50	—	5°	14·91	35·15	26·13	1·00	—	5·81	,,	250–100			
		75	—	5°	14·89	35·15	26·13	1·00	—	—	,,	100–50			
		100	—	5°	13·36	35·15	26·46	1·00	—	3·23	,,	50–0	—	1446	
		150	—	10°	12·10	35·00	26·59	1·59	—	—	**N 100 B**	168–0	1745	1807	KT
		200	—	10°	11·25	34·93	26·69	1·85	—	2·29	**N 70 B**				
		300	—	15°	9·41	34·75	26·88	2·61	—	1·44	**N 100 H**	5–0	1750	1810	
		400	—	15°	7·96	34·63	27·01	2·75	—	1·19					
		600	—	20°	6·03	34·46	27·14	2·49	—	2·12					
		780^{2}	781	25°	4·64	34·43	27·29	2·36	—	2·78					
		990^{2}	986	25°	3·91	34·29	27·25	2·23	—	3·51					
		1100^{1}	1104		3·62	34·51	27·46	1·98	—	3·61					
		1410^{1}	—	35°	3·37	34·67	27·61	1·51	—	3·67					
		1670^{1}	1667		3·34	34·54	27·51	1·51	—	4·45					
WS 1082	24	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1083	24–25	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1084	25	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
		1950												
WS 1085	21° 16′ S, 13° 22′ E	7 x	0638–0647	104 d.gn.M. H_2S	NW × N	4–10	NW	2	NNW	2	om	1017·0	13·9	13·3
WS 1086	20° 58′ S, 13° 10′ E	7 x	0920–0938	119 d.gn.M. St	NNW	1–3	—	0	NNW	1	om	1018·0	13·9	13·3
WS 1087	20° 54′ S, 13° 20′ E	7 x	1108–1120	69 d.gn.M. H_2S	Lt airs	0–3	—	0	NNW	1	om	1017·3	14·4	13·9
WS 1088	22° 02′ S, 11° 49′ E	8 x	0045–0142	—	SE	11–16	SW	2	SW	1	o	1014·5	15·0	14·4
WS 1089	21° 39′ S, 11° 55′ E	8 x	0445–0545	—	SE	4–6	SW	1	SW	2	om	1012·0	15·0	14·4
WS 1090	21° 11′ S, 12° 03′ E	8 x	0942–1025	—	SSE	7–10	SSE	1	SSE	1	om	1013·0	13·9	13·3
WS 1091	20° 38′ S, 12° 18′ E	8 x	1452–1553	313 y.gn. Fr.M	SW	4–6	SW	1	S	1	o	1012·0	15·0	14·4
WS 1092	20° 37′ S, 13° 14′ E	8 x	2200–2215	77 d.gn. Di.M. H_2S	WNW	7–10	WNW	2	NW	1	o	1014·3	13·9	13·3
WS 1093	20° 10′ S, 12° 29′ E	9 x	0433–0600	205*	WNW	11–16	NW	2	NW	2	oe	1013·0	13·9	13·3
WS 1094	20° 17′ S, 13° 07′ E	9 x	0938–0952	77 d.gn.M	Lt airs	0–3	—	0	NW	2	o	1015·0	13·9	13·3

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.³ P inorganic	P total	O_2 c.c. litre	BIOLOGICAL OBSERVATIONS Gear	Depth (metres)	TIME From	To	Remarks
WS 1085	25	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1086	25	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1087	25	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1088	26	0	—	—	16·1	—	—	—	—	—	BT	135–0	0046	0053	
		10	—	—	16·1	—	—	—	—	—	N 50 V	100–0	0052	0057	
		20	—	—	15·9	—	—	—	—	—	N 100 H	5–0	0117	0137	
		30	—	—	14·9										
		50	—	—	14·6										
		75	—	—	13·8										
		100	—	—	13·0										
		135	—	—	12·2										
WS 1089	26	0	—	—	15·6	—	—	—	—	—	BT	138–0	0455	0501	
		10	—	—	15·6	—	—	—	—	—	N 50 V	100–0	0456	0505	
		20	—	—	14·1	—	—	—	—	—	N 100 H	5–0	0519	0539	
		30	—	—	13·9										
		50	—	—	13·9										
		75	—	—	13·6										
		100	—	—	13·3										
		138	—	—	12·6										
WS 1090	26	0	—	—	15·3	—	—	—	—	—	BT	138–0	0941	0946	
		10	—	—	14·6	—	—	—	—	—	N 50 V	100–0	0943	0948	
		20	—	—	14·3	—	—	—	—	—	N 100 H	5–0	0958	1018	
		30	—	—	14·2										
		50	—	—	13·6										
		75	—	—	13·3										
		100	—	—	12·7										
		138	—	—	11·8										
WS 1091	26	0	—	—	15·6	—	—	—	—	—	BT	138–0	1515	1522	
		10	—	—	15·5	—	—	—	—	—	N 50 V	100–0	1518	1524	
		20	—	—	14·9	—	—	—	—	—	N 100 H	5–0	1531	1551	
		30	—	—	14·4										
		50	—	—	14·4										
		75	—	—	13·2										
		100	—	—	12·5										
		138	—	—	11·7										
WS 1092	26	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1093	27	0	—	—	14·2	—	—	—	—	—	N 50 V	100–0	0442	0448	
		10	—	—	14·2	—	—	—	—	—	BT	138–0	0512	0518	
		20	—	—	13·9	—	—	—	—	—	N 100 H	5–0	0529	0549	
		30	—	—	13·2										
		50	—	—	12·8										
		75	—	—	12·7										
		100	—	—	12·6										
		138	—	—	11·8										
WS 1094	27	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample

Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1095	19° 44′ S, 12° 47′ E	1950 9 x	1547–1552	79 d.gn. Di.M. H_2S	WNW	1–3	WNW	1	SW	2	o	1011·0	15·0	13·9
WS 1096	19° 43′ S, 12° 40′ E	9 x	1653–1939	110 d.gn.M. H_2S	WNW	4–6	WNW	1	SW	2	o	1010·5	15·0	14·4
WS 1097	19° 44′ S, 12° 21′ E	9–10 x	2300–0022	165 d.br.M. Sh	NNW	1–3	—	0	SW	2	om	1014·3	15·0	13·9
WS 1098	19° 44′ S, 12° 01′ E	10 x	0920–1408	304 gy.gn. Fr.M	Lt airs	—	—	0	SSW	2	om	1014·0	15·0	13·9
WS 1099	19° 44′ S, 11° 42′ E	10 x	1606–1720	380 gy.gn. Fr.M	W	4–6	W	1	S	2	o	1012·5	16·7	15·0
WS 1100	19° 44′ S, 11° 23′ E	10–11 x	2100–0040	677 y.gn. Gl.Oz	Lt airs	—	—	0	S	2	o	1014·2	15·6	14·4
WS 1101	19° 45′ S, 11° 05′ E	11 x	1345–1455	1105 y.gn. Fr.Oz	SSW	1–3	SSW	1	SW	1	o	1014·0	17·2	15·6

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS: Depth (metres)	Depth by thermo-meter	Wire angle	Temp. °C.	S ‰	σt	Mg.-atom m.^{3}: P inorganic	P total	O_2 c.c. litre	BIOLOGICAL OBSERVATIONS: Gear	Depth (metres)	TIME: From	To	Remarks
WS 1095	27	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1096	27	0	—	0°	14·71	35·02	26·08	0·13	—	8·21	NH	0	1700	1720	
		10	—	0°	13·49	35·01	26·32	0·67	—	—	LH	*ca.* 25	1700	1908	
		20	—	0°	12·90	35·01	26·44	1·42	—	4·56	N 50 V	100–0	1704	1711	
		30	—	0°	12·48	35·01	26·53	1·76	—	—	N 70 V	100–50	1725		
		50	—	0°	12·17	35·03	26·60	1·85	—	2·17	,,	50–0	—	1740	
		75	—	0	11·77	35·01	26·66	2·49	—	—	N 100 H	5–0	1909	1929	
		100	—	0°	11·73	35·01	26·67	2·55	—	0·26					
WS 1097	27	0	—	—	14·3	—	—	—	—	—	N 50 V	100–0	2324	2329	
		10	—	—	14·2	—	—	—	—	—	BT	138–0	2333	2340	
		20	—	—	14·2	—	—	—	—	—	N 100 H	5–0	0000	0020	
		30	—	—	14·1	—	—	—	—	—	LH	*ca.* 25			During and fol- [lowing Station
		50	—	—	13·4										
		75	—	—	13·2										
		100	—	—	12·4										
		138	—	—	11·8										
WS 1098	28	0	—	0°	15·11	35·16	26·08	0·92	—	6·27	N 50 V	100–0	1124	1130	
		10	—	0°	14·70	35·16	26·17	1·00	—	—	N 70 V	250–100	1140		
		20	—	0°	14·43	35·16	26·23	1·00	—	5·64	,,	100–50			
		30	—	0°	14·34	35·17	26·27	1·00	—	—	,,	50–0	—	1210	
		50	—	0°	14·15	35·16	26·29	1·08	—	5·31	N 100 B	181–0	1338	1403	KT
		75	—	2°	13·84	35·16	26·36	1·34	—	—	N 70 B				
		100	—	3°	12·72	35·10	26·55	1·76	—	3·13	N 100 H	5–0	1346	1406	
		150	—	3°	12·43	35·10	26·60	1·85							
		200	—	5°	12·08	35·11	26·68	1·85	—	1·66					
		300	—	5°	10·94	34·99	26·80	2·23	—	0·35					
WS 1099	28	0	—	—	16·2	—	—	—	—	—	N 50 V	100–0	1621	1627	
		10	—	—	15·9	—	—	—	—	—	BT	138–0	1625	1631	
		20	—	—	15·1	—	—	—	—	—	N 100 H	5–0	1655	1715	
		30	—	—	14·4										
		50	—	—	13·3										
		75	—	—	13·3										
		100	—	—	12·9										
		138	—	—	12·7										
WS 1100	28	0	—	0°	15·92	35·21	25·95	0·67	—	6·76	NH	0	2135	0010	
		10	—	0°	15·35	35·21	26·08	0·92	—	—	N 50 V	100–0	2158	2203	
		20	—	0°	15·04	35·21	26·15	1·00	—	6·17	N 70 V	500–250	2220		
		30	—	0°	14·94	35·21	26·17	1·17	—	—	,,	250–100			
		50	—	0°	14·42	35·20	26·27	1·00	—	5·45	,,	100–50			
		75	—	0°	14·26	35·21	26·32	1·17	—	—	,,	50–0	—	2311	
		100	—	0°	13·61	35·17	26·42	1·68	—	4·73	N 100 B	157–0	0009	0032	KT
		150	—	0°	12·97	35·12	26·51	1·68	—	—	N 70 B				
		200	—	0°	12·31	35·14	26·66	1·68	—	0·55	N 100 H	5–0	0012	0033	
		300	—	0°	10·25	34·87	26·83	1·85	—	1·28					
		400	—	10°	8·74	34·69	26·93	2·23	—	0·79					
		600	—	5°	5·95	34·51	27·19	2·61	—	1·88					
WS 1101	29	0	—	—	16·7	—	—	—	—	—	BT	138–0	1401	1406	Imperfect trace: [repeated
		10	—	—	16·2	—	—	—	—	—	N 50 V	100–0	1405	1410	
		15	—	—	14·9	—	—	—	—	—	BT	138–0	1409	1414	
		20	—	—	14·9	—	—	—	—	—	N 100 H	5–0	1432	1452	
		30	—	—	14·8										
		50	—	—	14·4										
		75	—	—	13·6										
		100	—	—	13·3										
		138	—	—	13·2										

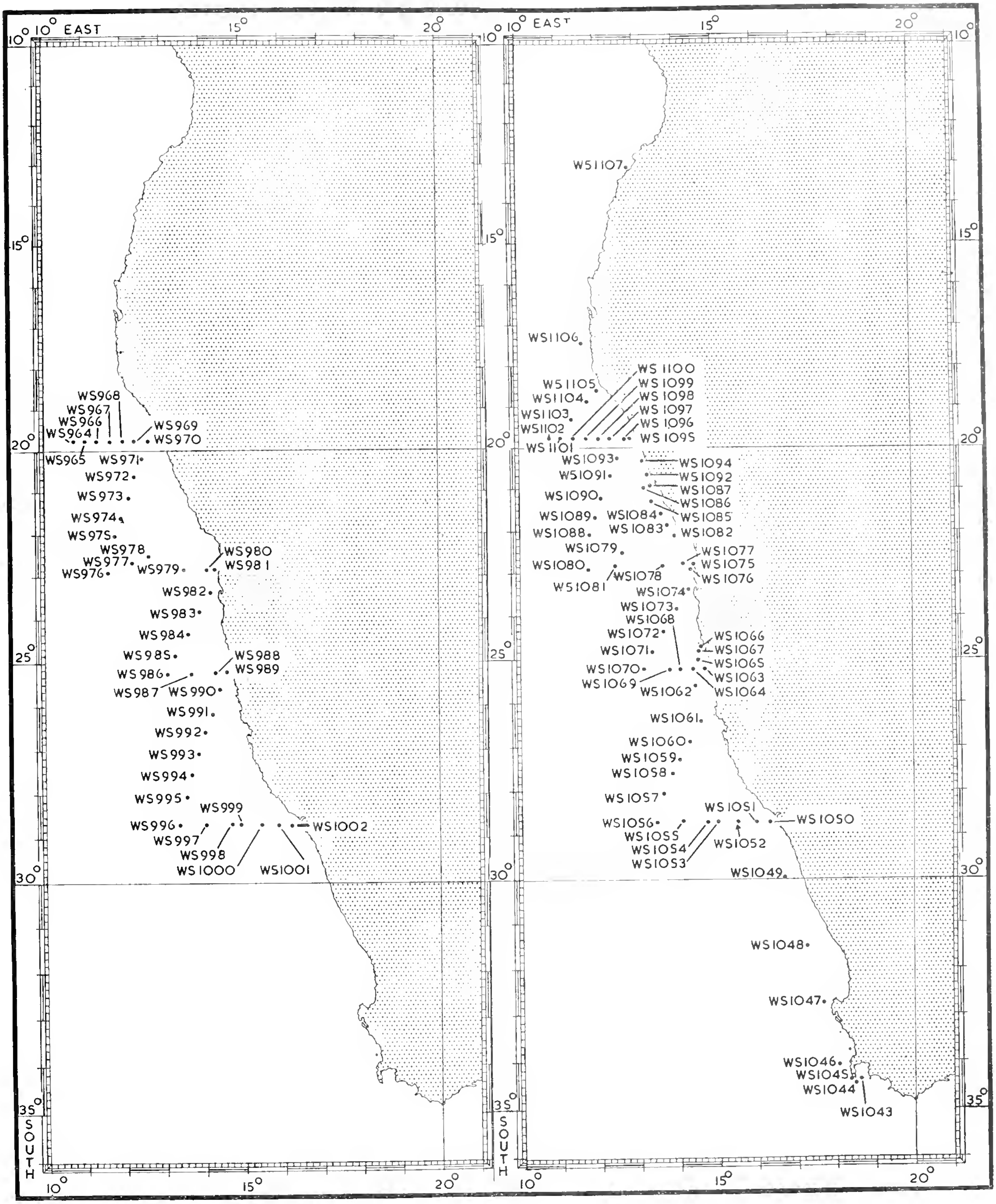
Station	Position	Date	Hour	Sounding (metres)	WIND		SEA		SWELL		Weather	Barometer (millibars)	Air Temp. °C.	
					Direction	Force (knots)	Direction	Force	Direction	Force			Dry bulb	Wet bulb
WS 1102	19° 44′ S, 10° 46′ E	1950 11 X	1707–	1181 y.gn. Gl.Oz	Lt airs	2–5	SSW	1	SW	1	0	1012·4	17·2	15·6
			2155		Lt airs	2–5	SSW	1	SW	1	0	1015·0	16·7	15·6
WS 1103	19° 16′ S, 11° 18′ E	12 X	0238– 0343	673*	SSE	4–6	SSE	1	S	1	0	1015·0	16·7	15·0
WS 1104	18° 52′ S, 11° 44′ E	12 X	0813– 0917	271*	SE	7–10	SE	3	—	0	0	1013·6	16·1	14·4
WS 1105	18° 34′ S, 12° 00′ E	12 X	1229– 1343	79 d.gn.M. H_2S	SE	4–6	S	2	SSE	1	0	1013·4	16·1	15·0
WS 1106	17° 26′ S, 11° 38′ E	13 X	0215– 0233	80 d.gn.M. H_2S	S	7–10	S	1	S	1	0	1014·0	15·6	15·0
WS 1107	13° 05′ S, 12° 50′ E	14 X	1520– 1523	77 br.gn. S & Sh	Calm	0	—	0	—	0	b	1012·0	21·7	20·0

Station	Age of moon (days)	HYDROLOGICAL OBSERVATIONS: Depth (metres)	Depth by thermometer	Wire angle	Temp. °C.	S ‰	σt	Mg-atom m.³ P inorganic	P total	O_2 c.c./litre	BIOLOGICAL OBSERVATIONS: Gear	Depth (metres)	TIME From	To	Remark
WS 1102	29	0	—	0°	16·45	35·21	25·83	0·67	—	6·89	**N 50 V**	100–0	1722	1730	
		10	—	0	15·87	35·19	25·94	0·67	—	—	**N 70 V**	1000–750	1742		
	29	20	—	0	15·30	35·21	26·09	0·83	—	6·37	,,	750–500	—	—	Closed prematurely: [no catch, repeated
		30	—	0°	14·70	35·19	26·20	0·33	—	—	,,	750–500			
		50	—	0°	14·59	35·21	26·24	0·92	—	5·28	,,	500–250	—	—	Closed prematurely: [repeated
		75	—	0°	14·12	35·16	26·30	1·00	—	—	,,	500–250			
		100	—	0°	13·73	35·16	26·38	1·59	—	4·67	,,	250–100			
		150	—	2°	13·20	35·16	26·49	1·68	—	—	,,	100–50			
		200	—	3	12·10	35·05	26·62	1·85	—	0·99	,,	50–0	—	**2045**	
		300	—	5°	9·83	34·78	26·83	1·85	—	0·77	**NH**	0	1900	**2030**	
		400	—	5°	8·64	34·69	26·95	2·10	—	0·79	**N 100 B**	166–0	**2123**	**2145**	KT
		630[1]	627		6·03	34·31	27·02	2·23	—	1·93	**N 70 B**				
		820[1]	—	5°	4·51	34·40	27·27	2·36	—	2·77	**N 100 H**	5–0	**2126**	**2146**	
		960[1]	964		4·00	34·41	27·34	2·06	—	3·39					
WS 1103	0	0	—	—	15·8	—	—	—	—	—	**BT**	138–0	**0235**	**0242**	Poor trace: repeated
		10	—	—	15·5	—	—	—	—	—	**N 50 V**	100–0	**0244**	**0249**	
		20	—	—	14·4	—	—	—	—	—	**BT**	138–0	**0245**	**0252**	
		30	—	—	14·3	—	—	—	—	—	**NH**	0	**0250**	**0310**	
		50	—	—	14·1	—	—	—	—	—	**N 100 H**	5–0	**0319**	**0339**	
		75	—	—	13·7										
		100	—	—	13·4										
		138	—	—	13·2										
WS 1104	0	0	—	—	15·1	—	—	—	—	—	**BT**	135–0	0820	0826	
		10	—	—	14·8	—	—	—	—	—	**N 50 V**	100–0	0822	0828	
		20	—	—	14·2	—	—	—	—	—	**N 100 H**	5–0	0852	0912	
		30	—	—	14·1										
		50	—	—	13·7										
		75	—	—	13·3										
		100	—	—	12·8										
		135	—	—	12·5										
WS 1105	0	0	—	—	14·8	—	—	—	—	—	**LH**	*ca.* 25	1230	1305	
		10	—	—	14·3	—	—	—	—	—	**BT**	75–0	1243	1250	
		20	—	—	12·9	—	—	—	—	—	**N 50 V**	75–0	1245	1251	Net split: catch re- [tained
		30	—	—	12·9	—	—	—	—	—	**N 100 H**	5–0	1310	1330	
		50	—	—	12·8										
		75	—	—	12·8										
WS 1106	1	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample
WS 1107	2	—	—	—	—	—	—	—	—	—	—	—	—	—	Bottom sample. GMT = zone − 1 hr

SUMMARIZED LIST OF STATIONS

The positions of the stations made by the R.R.S. 'William Scoresby' between January and October 1950 are shown on the charts in Plates XI and XII. At the fishing stations off East London, the course of the trawls and positions of the long lines have been inserted appropriately. The following list indicates on which chart the stations are to be found:

Stations	Date	Area	Plate
WS 960–963	18. i. 50–19. i. 50	South-west of Ireland	XII
WS 964–1002	4. iii. 50–14. iii. 50	Off South-West Africa	XI
WS 1003–1012	2. v. 50–10. v. 50	Off East London	XII
WS 1013–1021	27. vi. 50–16. vii. 50	Indian Ocean	XII
WS 1022–1030	27. vii. 50–4. viii. 50	South of Madagascar and Mozambique Channel	XII
WS 1031–1042	3. ix. 50–8. ix. 50	Off East London (Agulhas Current)	XII
WS 1043–1107	19. ix. 50–14. x. 50	Off South-West Africa	XI


10° EAST
15°
20°
SOUTH
WS968
WS967
WS966
WS964
WS965
WS969
WS970
WS971
WS972
WS973
WS974
WS975
WS978
WS977
WS976
WS979
WS980
WS981
WS982
WS983
WS984
WS985
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WS1002
WS1107
WS1106
WS1100
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WS1103
WS1097
WS1102
WS1096
WS1101
WS1095
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WS1057
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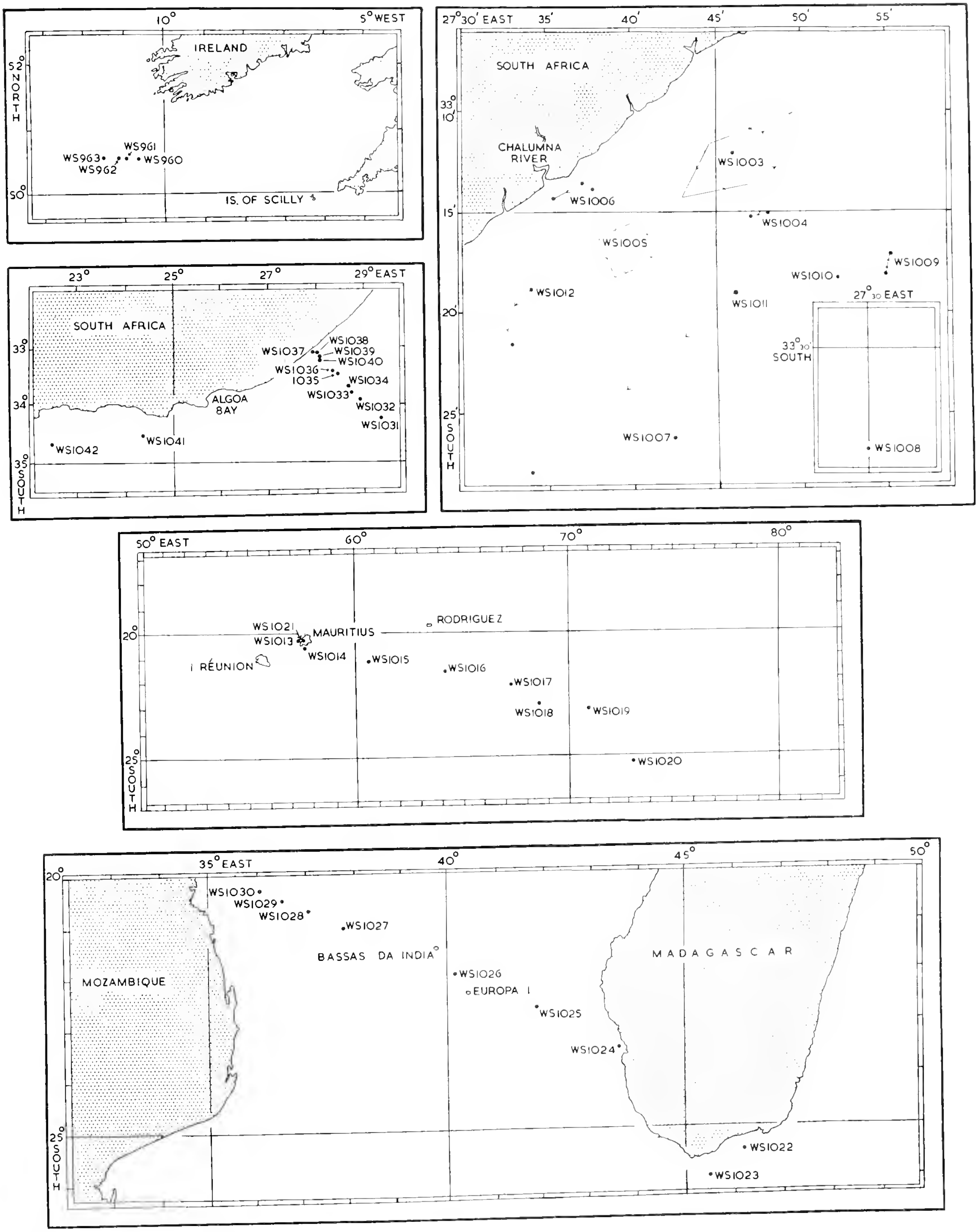
WS1052
WS1054
WS1053
WS1049
WS1048
WS1047
WS1046
WS1045
WS1044
WS1043


10°
5° WEST
52° NORTH
50°
IRELAND
WS961
WS963
WS962
WS960
IS. OF SCILLY
27° 30' EAST
35'
40'
45'
50'
55'
33° 10'
15'
20'
25' SOUTH
SOUTH AFRICA
CHALUMNA RIVER
WS1003
WS1006
WS1004
WS1005
WS1009
WS1010
WS1012
WS1011
27° 30' EAST
33° 30' SOUTH
WS1007
WS1008
23°
25°
27°
29° EAST
33°
34°
35° SOUTH
SOUTH AFRICA
WS1038
WS1037
WS1039
WS1040
WS1036
1035
WS1034
WS1033
ALGOA BAY
WS1032
WS1031
WS1041
WS1042
50° EAST
60°
70°
80°
20°
25° SOUTH
RODRIGUEZ
WS1021
MAURITIUS
WS1013
WS1014
WS1015
I RÉUNION
WS1016
WS1017
WS1018
WS1019
WS1020
20°
35° EAST
40°
45°
50°
25° SOUTH
WS1030
WS1029
WS1028
WS1027
BASSAS DA INDIA
WS1026
EUROPA I
MOZAMBIQUE
MADAGASCAR
WS1025
WS1024
WS1022
WS1023

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A PRELIMINARY REPORT ON THE OSTRACODA OF THE BENGUELA CURRENT

By

E. J. ILES

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(Text-figs. 1–5)

INTRODUCTION

The R.R.S. 'William Scoresby' carried out two surveys of the Benguela current in 1950, the first in March, and the second in September–October. Some of the results of these surveys have been briefly described by Hart (1953) and Currie (1953), but some time will no doubt be needed for the full analysis of the data, and especially for examination of the collections of plankton. Dr T. J. Hart has carried out the laborious task of sorting the samples of zooplankton, and at the invitation of Dr N. A. Mackintosh I undertook to examine and report upon the Ostracods. The sorting has been so effective that I have received all the material from the first survey, including the early juvenile stages. The present report is based on this material: that is to say it is limited to the first of the two surveys, and at this stage I have thought it best simply to give an account of the species identified, to note the numbers in which they occur in the samples, and to draw attention to certain aspects of their horizontal and vertical distribution. It is hoped that a report on these lines will materially assist a wider study of the fauna of the Benguela current and its relations to the hydrographic features of this interesting region.

With the exception of a very few species the planktonic Ostracods of the open sea belong to a single family, the Halocypridae. Previous marine expeditions have provided material that has made possible the recognition of what is probably the majority of the existing species of the family. A series of workers (Claus, Brady, Müller, Vavra, Sars, etc.) have worked out these collections but their descriptions are mainly limited to a few diagnostic features. More recently Skogsberg (1920, 1946) re-described certain species and drew attention to the inadequate nature of the previous descriptions. Although, as he pointed out, taxonomic revision of the family is clearly needed, re-description of many more species will be necessary before this can be done. However, I have decided that it would be preferable to postpone re-description of the species considered in this report until material with a much wider range of distribution has been examined. The species found in the samples have thus, with one exception, been determined and classified on the basis of existing taxonomic knowledge. They are listed below with the appropriate authorities. The juvenile stages of the Halocypridae have not been adequately described in the literature and therefore the early stages whose identity cannot yet be established have been listed as 'unidentified juveniles'. Numerical data regarding material from the samples are included in the tables, which form an appendix to this report.

I wish to acknowledge my indebtedness to the National Institute of Oceanography for the opportunity of examining the material. I should also record my sincere thanks to Dr Mackintosh for the trouble he has taken in reading through and checking the typescript, and to Dr Hart for the information he has supplied. Dr J. P. Harding of the British Museum (Natural History) has very kindly given me details of the type material of *Halocypris punica* Scott. Finally, I wish to thank Prof. H. Graham Cannon for introducing me to the field of study of Ostracod taxonomy and for his continued interest and advice during the progress of my work.

THE MATERIAL EXAMINED

The plankton samples of the first survey were taken on a series of three transverse lines of stations across the Benguela current off the coast of South-west Africa (Fig. 1).[1] These samples were taken with a series of vertical closing nets of the N 70 pattern shot to a maximum depth of 1000 metres or less, depending upon the depth of water at the station. The soundings show that the outermost station of each line was in a depth of water of some 2000 m. or 3000 m., while the lines then proceeded up the Continental Slope, a few stations in each being over the Continental Shelf.

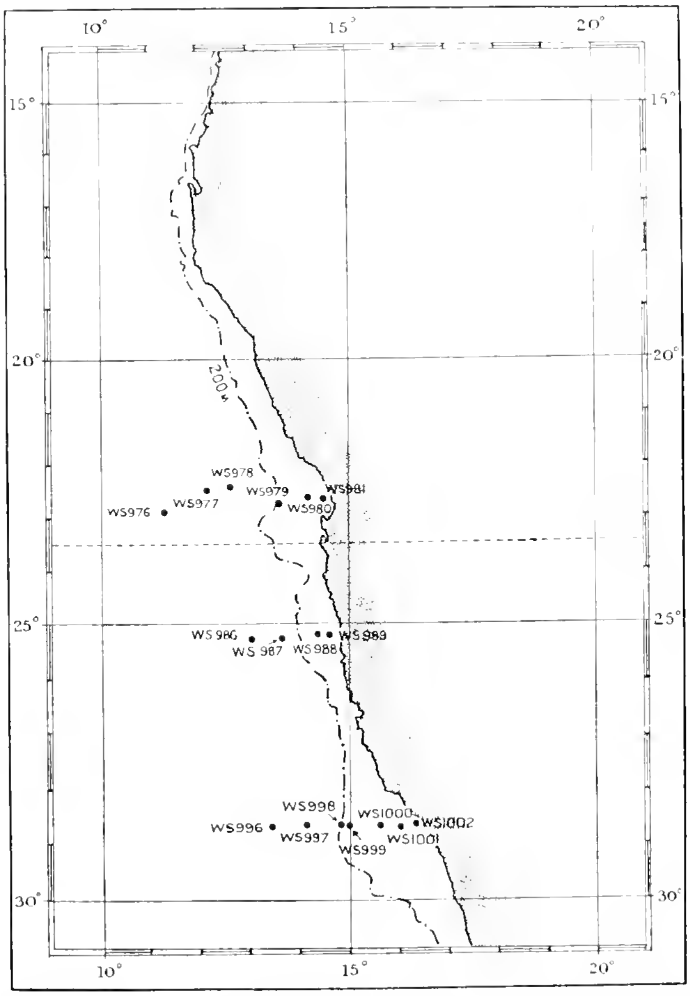

Fig. 1. Sketch-map of the area off the west coast of Africa where samples were taken, showing the approximate positions of the stations.

SPECIES PRESENT IN THE SAMPLES

Conchoecia rotundata Müller aff.

Skogsberg (1920) pointed out that the species *C. rotundata* as described by Müller (1906) is probably a mixture of closely allied species, and the material from the Benguela current has made it possible to confirm this hypothesis.

Müller (1890) described the species *C. rotundata* on the basis of a few specimens obtained in deep water at two positions in the tropical Pacific. These were in 13° N., 120° W. at a depth of 1000 m., and in 1° S., 100° W. at 4000 m. (According to Schott (1935, pp. 199–203) the temperatures at

[1] Particulars have now been published in a new Station List in the Discovery Reports.

these depths were 4·60° C. and 1·85° C. respectively). The description was brief and even failed to give adequate details of the unsymmetric glands. The same author (1894) ascribed material from the Mediterranean to the same species. The length of typical specimens in this material was only 0·8 mm. as opposed to 1·15 mm. in the case of the Pacific material, and there were fewer pairs of spines on the principal seta of the male antennule (eight instead of ten). The frontal organ of the male also differed.

The 'Valdivia' Expedition provided a large quantity of material from the Atlantic and Antarctic including species allied to *C. rotundata*, which Müller (1906) distinguished and named. It included material which resembled his previous specimens of *C. rotundata*, and also longer specimens (up to 1·75 mm. in length) with similar features, such as the position of the unsymmetric glands. He included the longer forms in the same species. He noted that the 'long forms' were typical of the Antarctic and the 'short forms' of warmer waters, but assumed that he was dealing with a very variable species.

Fowler (1909), while studying the planktonic Ostracoda of the Bay of Biscay, obtained specimens of both the 'long' and 'short forms'. He interpreted the two 'forms' on the basis that the 'long forms' were adult and the 'short forms' juveniles of the same species.

Further material from the Antarctic was examined by Skogsberg (1920). He obtained specimens of the 'long forms' and described them in some detail, noting that they agreed with the 'long forms' described by Müller. He did not find any of the 'short forms', considered that Fowler was mistaken in supposing them to be juveniles, and decided that they belonged to a nearly related species, possibly *C. nasotuberculata*. He concluded in fact that Müller's *C. rotundata* might be a mixture of closely allied species.

The samples collected by the 'William Scoresby' in the Benguela current provide further material of both the 'long forms' and the 'short forms' of *C. rotundata* as described by Müller (1906). Both these 'forms' occur at the same stations and in some instances in the same samples. There are fully matured male and female specimens and also juveniles of each type. The use of closing-nets and the numbers of adults of each form in each sample shows that there is a clear difference in their depth distribution. Table 1 gives the total number of 'short forms' of *C. rotundata* taken at the different stations, and the proportion collected at depths above 250 m. is compared with the figures for the 'long forms' and for *C. nasotuberculata*. Only one specimen from a total of twenty-three 'long forms' was captured above 250 m., whereas many more 'short forms' occurred in samples taken above 250 m. than below. *C. nasotuberculata*, clearly distinguishable morphologically from the 'short forms', occurs in the same samples. Its depth distribution (Table 1) falls somewhat between that of the two 'forms' under consideration.

Table 1. *Comparative depth distribution of 'long' and 'short forms' of* C. rotundata *and* C. nasotuberculata

Station	'Short forms'			'Long forms'		*C. nasotuberculata*		
	Total No.	Above 250 m.		Total No.	Above 250 m.	Total No.	Above 250 m.	
		No.	%		No.		No.	%
WS 976	73	47	64	1	0	21	1	5
WS 977	23	21	91	7	0	47	21	45
WS 978	9	7	78	5	0	36	3	8
WS 980	1	1	100	0	0	0	0	0
WS 986	7	6	86	7	0	39	7	18
WS 996	9	8	89	2	1	9	3	33
WS 997	2	2	100	0	0	1	0	0
WS 998	1	1	100	0	0	0	0	0

An examination of the material shows clear morphological differences between the two 'forms'. Specimens of the 'long form' agree in structure with those described by Skogsberg (1920) from his Antarctic material. The 'short forms' agree in structure with the material from the Mediterranean described by Müller (1894) as *C. rotundata*.

As Skogsberg (1920) has pointed out, the form of the shell is a characteristic feature of the species of *Conchoecia*. This differs markedly in the two 'forms' considered here. The 'long forms' have a greater ratio of length to depth and their greatest depth is anterior to the middle of the length, as opposed to posterior in the 'short forms'. They have, in the material so far examined, a length of 1·4 mm. or more, as opposed to 0·8–0·9 mm. in the case of the 'short forms'. Although the form and spacing of the spines of the principle ('*e*') seta of the male antennule is similar in the two, the 'long forms' have 14–15 pairs whereas the 'short forms' have 9–10 pairs. The clasping organ of the endopodite of the right male antenna in the 'short forms' is similar to that of *C. kyrtophora* or *C. nasotuberculata*, being sharply angled rather than smoothly curved as in the case of the 'long forms'. The frontal organ of the male is similar in the two but the 'long forms' have a dorsal insection which is absent in the 'short'.

Through the kindness of the authorities of the British Museum (Natural History), it has been possible to re-examine Fowler's material from the Bay of Biscay. His stage I of *C. rotundata* agrees with the 'long forms' and his stage II with the 'short forms'.

It is clear that the two 'forms' are separate species, the 'short form' typical of the Mediterranean and warmer waters of the Atlantic, the 'long form' characteristic of the Antarctic and colder water, at least in the Atlantic. The problem of specific identity remains. Both these species have previously been ascribed to *C. rotundata* Müller. The original description (Müller, 1890) is inadequate even in respect to diagnostic characters. On the basis of the described and figured outline of the shell and the ten pairs of spines on the principal seta of the male antennule, together with the length of 1·15 mm. as opposed to 1·4 mm. or more in the 'long forms', it is clear that the latter are specifically distinct and must be renamed. Morphological differences between the 'short forms' and the type description of *C. rotundata* are slight and may or may not be significant. The length of the specimens under consideration, as well as that of Müller's Mediterranean material, is less than that of his Pacific material. The shape of the male frontal organ in the original description more nearly resembles that of the 'long forms'. It would therefore seem preferable to treat the two 'forms' as distinct species.

Müller (1912) included *Halocypris punica* Scott (1894) as a possible synonym of *Conchoecia rotundata* and it is necessary therefore to consider the possibility of this name being applicable to either species. As Skogsberg (1920) has pointed out, the original description is of a specimen differing so much that it is unlikely to be a synonym of *C. rotundata*. Dr J. P. Harding of the British Museum has very kindly examined the type material. The tube contains the shell of the animal described by Scott, together with other obviously unrelated material. It is clear that it differs so widely that it cannot be the same species as either *C. rotundata* or the two species considered here.

The specific name *C. rotundata* should thus, for the present, be restricted to the Pacific material described by Müller (1890, p. 275, pl. XXVIII, figs. 41–3; pl. XXIX, fig. 44). The other two species have been named as follows:

Conchoecia skogsbergi n.sp. ('long forms').

C. rotundata (part) Müller, 1906, p. 83 (part); pl. XVII, figs. 25–9 (not 23–4); (?)figs. 30–4.
C. rotundata (Stage I) Fowler, 1909, p. 273; pl. 23, fig. 206; pl. 24, figs. 205, 215.
C. rotundata (part) Müller, 1912, p. 77.
C. rotundata Skogsberg, 1920, p. 649 *et seq.*; figs. CXXII and CXXIII.

The description and figures given by Skogsberg (1920, p. 649) under the name *Conchoecia rotundata* may be taken as typical for this species. Type material will be deposited at the British Museum. The distribution known at present is in the Antarctic and colder waters of the Atlantic, distribution northwards possibly being due to the cold Benguela current. In the present series of samples moderate numbers of adults and juveniles occurred at Stations WS 976–8, 986 and 996 mainly at depths below 250 m. A single juvenile was in the 500–250 m. sample from Station WS 997.

The species may be distinguished from other known species of the genus *Conchoecia* by the shape of the shell coupled with the position of the unsymmetric glands. Confirmatory characters of the male are the number of pairs of spines on the principal seta of the antennule, the form of the clasping organ of the antenna and the frontal organ.

The new specific name has been chosen in acknowledgement of Skogsberg's realization that more than one species might have been confused under the name *C. rotundata*.

Conchoecia teretivalvata n.sp. ('short forms').

C. rotundata Müller, 1894, p. 229; pl. 16, figs. 16, 18–20 (not fig. 17); pl. 8, fig. 33.
C. rotundata Müller, 1906, p. 83 part.
C. rotundata (stage II) Fowler, 1909, p. 273.
C. rotundata (part) Müller, 1912, p. 77.

DIAGNOSTIC DESCRIPTION. *Male.* Length 0·8–0·9 mm. Shell (Fig. 2*a*) resembling that of *C. kyrtophora* in profile, but with the shoulder vaults poorly developed and the whole surface smoothly convex as in the case of *C. skogsbergi*. The posterior dorsal angle is strongly obtuse, the posterior margin being convex and continuing smoothly into the ventral margin. The greatest depth of the shell valves is just posterior to the middle of the length, and the depth decreases sharply anterior to this point. The left unsymmetric gland (Fig. 2*b*) is situated near the base of the rostrum, just posterior to the anterior extremity of the hinge. The right unsymmetric gland (Fig. 2*c*) opens level with the margin of the shell near the posterior extremity of the hinge, there being no tubercle. Medial glands are moderately well developed. Striation of the shell is similar in arrangement to that of *C. nasotuberculata* but very weak and difficult to observe.

The principal ('*e*') seta of the antennule (Fig. 3*c*) has nine or ten pairs of spines arranged in two rows with the spines of each pair level with one another. Each spine is sharply basally directed, parallel to the seta. The more basal spines are slightly longer than the more distal and the three most basal pairs succeed one another at wider intervals than the distal pairs. The proximal setae have a few extremely fine distally directed setules level with the distal spines of the principal seta.

The endopodite of the antenna closely resembles that of *C. skogsbergi* (see Skogsberg, 1920, under *C. rotundata*) but the clasping organs differ. The right clasping organ (Fig. 3*b*) is bent at a right-angle and has the apical portion slightly recurved. It has well-marked transverse striae distally. The left clasping organ (Fig. 3*a*) is smoothly curved and slightly recurved at the apex. The apical transverse striae are indistinct.

The dorsal boundary of the capitulum of the frontal organ (Fig. 2*d*) is slightly and smoothly concave. Basally it is considerably swollen, which portion bears a few conspicuous ventral spines.

Female. Length about 0·9 mm. The shell (Fig. 2*f*) resembles that of the male in general features though it has a greater depth in proportion to its length. It lacks the well-marked shoulder vaults and posterior tubercle, which are present in the similar species, *C. kyrtophora* and *C. nasotuberculata*.

The frontal organ (Fig. 2*e*) has a capitulum with a length slightly more than four times the breadth, and slightly tapering anterior to the middle of its length. The apex is rounded and the whole ventral margin bears short fine spines.

Present knowledge indicates that the distribution of this species is in the Mediterranean and the warmer waters of the Atlantic. In the Benguela current samples it occurred at Stations WS 975–8, 980, 986 and 996–8, with a much larger number of specimens in samples above 250 m. than below.

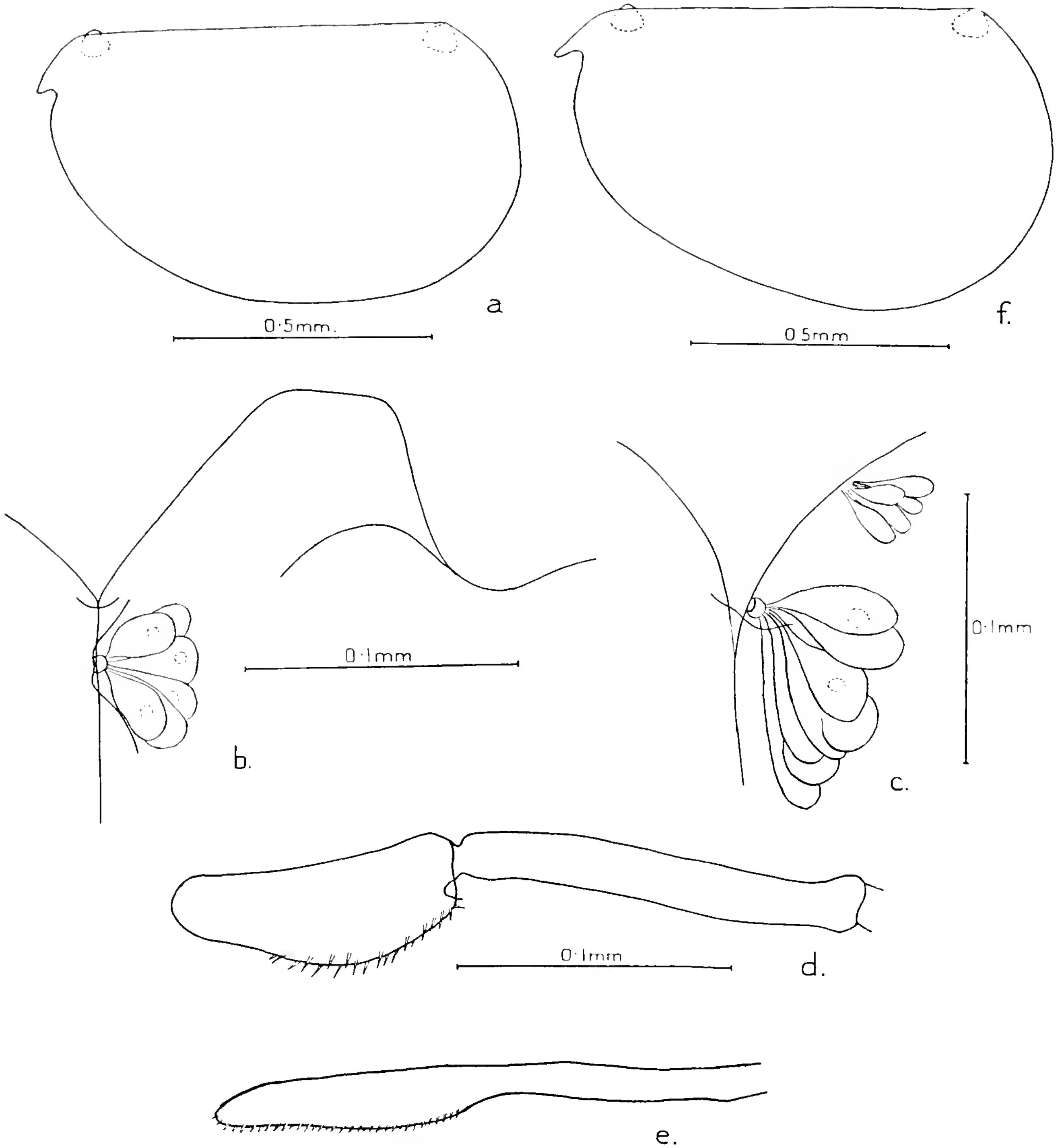

Fig. 2. *C. teretivalvata* n.sp. *a*, male from left side; *b*, anterior (left) unsymmetric gland of male from inside the shell; *c*, posterior (right) unsymmetric gland and medial gland of male from inside the shell; *d*, frontal organ of male; *e*, frontal organ of female; *f*, female from left side. (Figs. *b*, *c*, *d* from holotype; *a*, *e* and *f* from paratypes.)

The species may be distinguished from other species of the genus, except *C. rotundata* Müller, by the form of the shell coupled with the position of the unsymmetric glands. As far as is known, it differs from *C. rotundata* morphologically in its size, and in the form of the male frontal organ, as well as in its distribution.

Other species present in the samples were as follows:

Conchoecia alata Müller.

Conchoecia alata Müller, 1906, p. 121; pl. 29, figs. 1–10.
C. alata Müller, 1912, p. 92.

Numerous specimens at Stations WS 976–8, 986, 996, 997.

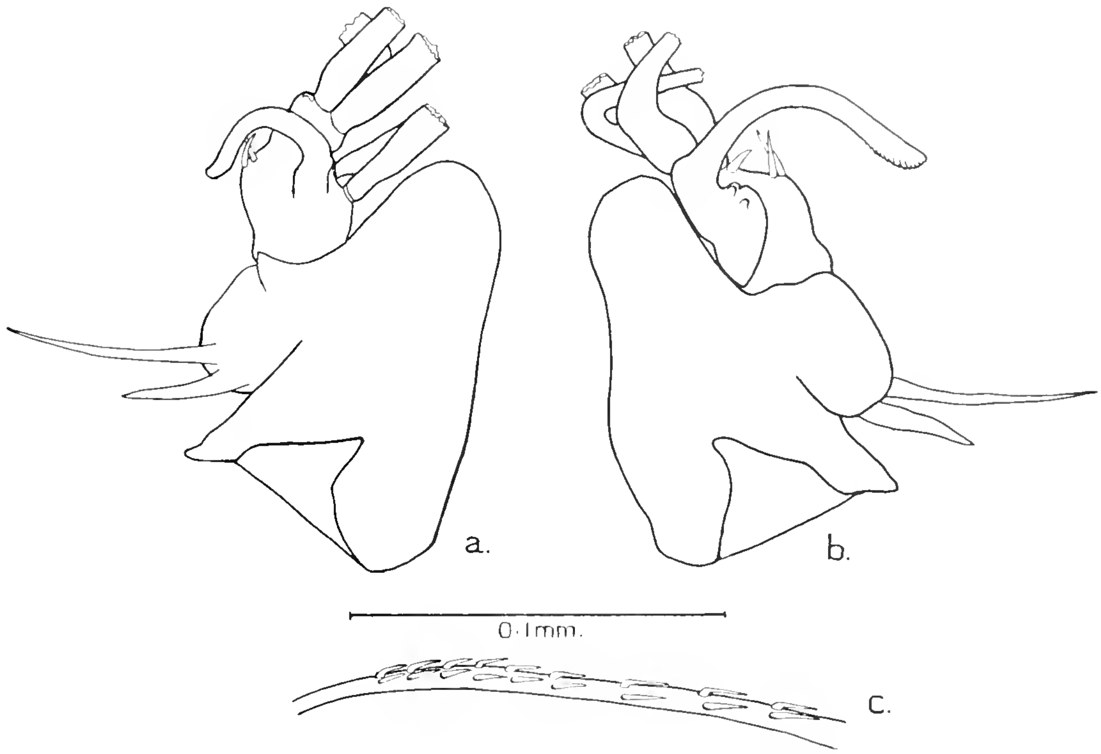

Fig. 3. *C. teretivalvata* n.sp. *a*, exopodite of male left antenna; *b*, exopodite of male right antenna; *c*, armature of principal seta of male antennule. (All from holotype.)

Conchoecia bispinosa Claus.

For synonymy and description see Skogsberg, 1920, p. 672, fig. CXXVIII.

This species occurred in samples from stations WS 976, 986, 996 and 997. Skogsberg (1920) has pointed out the close resemblance between this species and *C. haddoni* Brady & Norman. The two species are distinguishable by the short spines on the posterior dorsal angle of the shell of *C. bispinosa* and the number of spines on the principal setae of the first antennae of the males. Skogsberg states (1920, p. 675) that the areas of distribution of the two species do not coincide. Müller (1906, 1908), however, recorded the two species from the same plankton samples, and in the samples at present under consideration they also occur together. There must then be at least an overlap in their distribution.

Conchoecia chuni Müller.

For synonymy and description see Skogsberg, 1920, p. 636, fig. CXIX.

A single adult female occurred in the 250–100 m. sample from Station WS 996.

Conchoecia curta Lubbock.

The synonymy of this species is extremely complex and uncertain. Skogsberg (1920) discussed the position and re-described the species. The material from the Benguela current first survey clearly falls within the scope of the species as described by him. It was present in large numbers, of both adults

and juveniles, in samples from Stations WS 976, 978, 986, 996 and 997. A single juvenile was found in the 100–50 m. sample from Station WS 1001. It clearly formed a major part of the Ostracod fauna in the area at the time when the samples were taken. Certain features of its distribution will be discussed later in this report.

Conchoecia daphnoides (Claus).

For synonymy and description see Skogsberg, 1946, pp. 20–4, fig. v, 1–4.

An adult female of this species was found at Station WS 986 and single adult males at Stations WS 996 and 997. A juvenile was found at Station WS 976. All specimens were in the 750–500 m. samples.

Conchoecia echinata Müller.

Conchoecia echinata Müller, 1906, p. 61; pl. 10, figs. 14–24.
C. notocera Vavra, 1906, p. 58; pl. 6, figs. 114–20.
C. echinata Müller, 1908, p. 3.
C. echinata Müller, 1912, p. 70.

Present at Stations WS 976–8, 986, 996 and 997

The previously recorded range of this species extends from 31° N. (Vavra, 1906) to 14° S. (Müller, 1908) in the Atlantic. The material from the Benguela current stations extends the range of the species further south.

Conchoecia edentata Müller.

Conchoecia edentata Müller, 1906, p. 76; pl. xv, figs. 24–9.
C. edentata Müller, 1912, p. 74.
C. edentata Barney, 1921, p. 183–4, fig. 5.

A single female of this species was found in the 500–250 m. sample from Station WS 976.

The species was initially described by Müller (1906) on the basis of a single male and a juvenile female, which latter he did not describe. Barney (1921) found two males and two females which he ascribed to the species and gave a brief description of the female. All these previous specimens were found in the Antarctic. The present specimen agrees so closely with the previous descriptions as to warrant inclusion in the species. It is, however, further north than previously recorded.

Conchoecia elegans Sars.

For synonymy and descriptions see Skogsberg, 1920, p. 624, figs. cxvii and cxviii, and Sars, 1928, p. 23, pls. xi and xii.

A large proportion of the specimens found in the samples belongs to this species. It was found at Stations WS 976–8, 986, 996–8. Its distribution will be discussed in more detail later in this report.

Conchoecia haddoni Brady & Norman.

For synonymy and description see Skogsberg, 1920, p. 668; fig. cxxvii.

A few specimens were present in the samples, most of them from Station WS 996. Single adult females were found at Stations WS 976 and 997, as were also single juveniles. See also remarks under *C. bispinosa* above.

Conchoecia hirsuta Müller.

Conchoecia hirsuta Müller, 1906, p. 60; pl. 11, figs. 1–3 and 6–10; 1908, p. 69; 1912, p. 66.

A single male of this species was found in the 1000–750 m. sample at Station WS 986.

Conchoecia lophura Müller.

For synonymy and description see Skogsberg, 1920, p. 689, fig. CXXXI.

Single adults of this species were present in samples from Stations WS 976, 986 and 997. There were two juveniles in samples from WS 986 and one from Station WS 996.

Conchoecia loricata (Claus).

Conchoecissa loricata Claus, 1894, p. 4; pl. 3, fig. 24–30.
Conchoecia loricata Müller, 1906, p. 95; pl. 22, figs. 1–9.
C. loricata loricata Müller, 1912, p. 80.

A few specimens of adults and juveniles of this species occurred in samples taken below 250 m. at Stations WS 976–8, 986, 996 and 997.

Müller (1906) distinguished two varieties of the species, which he called var. *typica* and var. *minor*. The latter differed from the former in being smaller, having only twelve pairs of spines on the proximal seta of the antennule instead of about twenty-two, and having less marked striae on the shell. In a later publication (1912) he refers to the former as *C. loricata loricata*. The present material would appear to fall within the scope of *C. loricata loricata* though it has fewer spines on the proximal seta. The range of variation and status of the 'varieties' cannot be determined before a considerably greater bulk of material has been examined.

Conchoecia macromma Müller.

Conchoecia macromma Müller, 1906, p. 79; pl. 17, figs. 11–22.
C. macromma Müller, 1912, p. 75.

A single adult female of this species was present in the 1000–750 m. sample from Station WS 986.

Conchoecia mamillata Müller.

Conchoecia mamillata Müller, 1906, p. 60; pl. 16, figs. 1–9; pl. 35, fig. 8.
C. mamillata Müller, 1912, p. 70.

A single adult female was found in the 1000–750 m. sample from station WS 976.

(?) **Conchoecia mollis** Müller.

Conchoecia mollis Müller, 1906, p. 106; pl. 24, figs. 1–10 and 13.
C. mollis Müller, 1912, p. 85.

A single adult female was found in the sample collected between 1000 and 750 m. at Station WS 996, which if not *C. mollis* itself is closely related to it. Existing descriptions only make it possible to distinguish the males of the group of species allied to *C. mollis*, and until more detailed descriptions of the females are available, doubt must remain regarding the identity of this particular specimen.

Conchoecia nasotuberculata Müller.

Conchoecia nasotuberculata Müller, 1906, p. 83; pl. 18, figs. 25–30.
C. nasotuberculata Müller, 1912, p. 76.

This species occurred in large numbers at Stations WS 976–8, 986, 996 and 997. Distributional data of this species will be discussed later in the report.

Conchoecia obtusata Sars var. *antarctica* Müller.

For description and synonymy see Skogsberg, 1920, p. 647.

The species occurred in moderate numbers at Stations WS 976, 977, 996, 997 and 998. The previously recorded range of distribution of the species was in the Atlantic from 53° S. (Skogsberg, 1920) to 26° S. (Müller, 1906). The present records thus extend the distribution in the Benguela current further north to 22° 39′ S. Müller (1906, p. 149) considered that although the variety is typically Antarctic in its distribution its range is extended northward by the cold Benguela current. The present records are not then surprising.

Conchoecia procera Müller.

Conchoecia variabilis (part) Müller, 1890, p. 273; pl. 28, figs. 27, 38.
C. procera Müller, 1894, p. 228; pl. 6, figs. 47, 48, 50–8.
Paraconchoecia oblonga Claus, 1894, p. 3; pl. 3, figs. 21–3.
C. procera Müller, 1906, p. 71; pl. 13, figs. 37–47; pl. 14, figs. 3–6.
C. procera Müller, 1912, p. 72.

A few adults of this species were found in samples from Stations WS 976 and 996. A single juvenile was found in the 500–250 m. sample from Station WS 977.

Conchoecia spinifera (Claus).

Paraconchoecia spinifera Claus, 1890, p. 14.
P. spinifera Claus, 1891, p. 64; pl. 10.
Conchoecia spinifera Müller, 1906, p. 56; pl. 9, figs. 1–10, 14, 15.
C. spinifera Müller, 1912, p. 69.

A single adult female occurred in the 500–250 m. sample from Station WS 996 and a single adult male in the 500–250 m. sample from Station WS 976.

Conchoecia subarcuata Claus.

For description and synonymy see Skogsberg, 1920, p. 695 and fig. CXXXIII.

Moderate numbers of this species were present in the samples from Stations WS 976–8, 986, 996 and 997.

Conchoecia symmetrica Müller.

For description and synonymy see Skogsberg, 1920, p. 719 and figs. CXXXVIII–CXLIV.

Moderate numbers were present in samples from Stations WS 976–8, 986, 996 and 997.

Halocypris brevirostris (Dana).

For description and synonymy see Skogsberg, 1920, p. 584; figs. CXII–CXV.

A single juvenile of this species was found in the sample from 250–100 m. at Station WS 997.

Cypridina sp.

A single unidentified juvenile of the genus *Cypridina* was found in the 250–100 m. sample from Station WS 978.

DISTRIBUTION OF SPECIES

Owing to the wide range of variables involved in the present limited series of samples available, it is not yet possible to interpret the distribution of species fully. As Fowler (1909) has pointed out there is an almost hourly variation in the distribution of Ostracods. Some numerical data are, however, worthy

of note. Only adults will be considered, since outstanding taxonomic problems regarding the juvenile stages make a complete analysis of these stages impossible at present. The data only refer to the time and conditions when the samples were taken.

Table 2 shows the total numbers of adults of each species captured at each station. The first striking feature is the large number of species of Halocyprids present in such a limited area. The second is the vast preponderance of *Conchoecia elegans*. Müller (1927), Elofson (1941) and others pointed out the cosmopolitan nature of this species, so that its presence is not surprising, but its large numbers will

Table 2. *The sounding and total numbers of adults of each species captured at each station*

WS Station	Sounding (m.)	*C. alata*	*C. bispinosa*	*C. chuni*	*C. curta*	*C. daphnoides*	*C. echinata*	*C. edentata*	*C. elegans*	*C. haddoni*	*C. hirsuta*	*C. lophura*	*C. loricata*	*C. macromma*	*C. mamillata*	*C. mollis* aff.	*C. nasotuberculata*	*C. obtusata*	*C. procera*	*C. skogsbergi*	*C. spinifera*	*C. subarcuata*	*C. symmetrica*	*C. teretivalvata*
976	ca. 3098	20	20	0	68	0	14	1	177	1	0	2	2	0	1	0	21	9	4	1	1	6	5	73
†977	1970*	18	0	0	2	0	5	0	192	0	0	0	1	0	0	0	47	1	0	7	0	4	1	23
†978	932	19	0	0	1	0	1	0	78	0	0	0	1	0	0	0	36	0	0	5	0	3	0	9
979 980 981	139 106 64	One adult *C. teretivalvata* at Station 980																						
986	> 1000	4	2	0	10	1	2	0	118	0	1	1	3	1	0	0	39	0	0	7	0	2	2	7
987 988 989	293 135 70	No adult Ostracods																						
996	2586*	3	3	1	20	1	2	0	134	8	0	0	1	0	0	1	9	5	1	2	1	0	3	9
997	1075–983	2	3	0	13	1	1	0	14	1	0	1	0	0	0	0	1	10	0	0	0	3	5	2
998	198	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
999 1000 1001 1002	171 188 121 69	No adult Ostracods																						

* Soundings not at actual station but nearby.
† Omitting duplicate samples and those in which the net failed to operate correctly.

require explanation when further data become available. *C. curta*, *C. nasotuberculata* and *C. teretivalvata* were also present in large numbers. Though *C. alata* was less numerous, it occurred in sufficient numbers to form an appreciable proportion of the material, particularly in samples between 250 and 750 m. Other species were much less numerous, but some occurring in total numbers of from sixteen to twenty-five were sufficiently evenly distributed to be considered typical of the particular series of samples. In the case of *C. bispinosa*, although a total of twenty-eight adults was found in the samples, nineteen of these were from 500–250 m. and 750–500 m. samples from Station WS 976. It would seem that when the samples were taken at this daylight station there may have been a localized swarm of this species.

As has been pointed out above, *C. echinata* has now been found south of its previously recorded range of distribution and *C. obtusata antarctica* north of its previously recorded range. *C. teretivalvata*,

a species typical of warmer waters, is present in the samples nearer the surface, and *C. skogsbergi*, typical of colder waters, is present in deeper samples. These instances are probably a result of the influence of the Benguela current.

Two previous expeditions, the 'Valdivia' (Müller, 1906) and the German South Polar (Müller, 1908), obtained plankton samples from the Benguela current in latitudes similar to those of the present series but further from the coast. All the species recorded here, with the exception of *C. echinata* and *C. obtusata antarctica*, were recorded by these expeditions. It is of interest to compare the species occurring in the Benguela current with those described from the east coast of Africa (Cannon, 1940). Cannon recorded *C. alata* and *C. atlantica* as the most numerous species. The second of these is totally absent from the present series of samples, though it is known to occur in similar latitudes out in mid-Atlantic.

The data given in Table 2 show the significant fact that along each line of stations, with a few minor exceptions, the nearer the stations were to the coast the fewer the number of adults of each species captured. At those stations where the sounding was less than 200 m., a single adult *C. teretivalvata* was captured at Station WS 980, and at Station WS 998 (near the edge of the Continental Shelf) single adults of *C. elegans*, *C. obtusata* and *C. teretivalvata* were taken in a 175–100 m. sample. Otherwise no adults were present. The comparatively small depth of water over the Continental Shelf will naturally limit the spread of those species which only occur in deeper water, though of course there may be other reasons for the scarcity of Ostracods in shallow water. An absence of specimens in the samples, however, does not necessarily indicate a complete absence of a species from the area in which the sample was taken. A comparison of the number of adults present in the 50–0 m. and 100–50 m. samples in the deeper water stations with the number in similar samples taken over the Continental Shelf shows marked differences. Thus in the six 50–0 m. samples taken at stations where the sounding was 932 m. or more, a total of 105 adults was found, an average of over seventeen per sample, and neglecting *C. elegans* at Station WS 977, for reasons which will be pointed out later, there was a total of twenty-two adults, an average of almost four per sample. Only two of the six samples were devoid of adult specimens. On the other hand, in twelve similar samples taken at stations where the sounding was 293 m. or less, there was not a single adult Ostracod. In six samples from the 100–50 m. net, taken at stations where the sounding was 932 m. or more, there was a total of forty-three adult Ostracods, an average of about seven per sample. Only one sample contained no specimens, while in nine similar samples taken at stations with soundings of 293 m. or less, a single adult specimen was found.

It appears, therefore, that although under the conditions when the samples were taken adult Ostracods occurred near the surface at stations where the water was deep, at the shallower water stations over the Continental Shelf there must have been some factor or factors (connected for example with temperature or water movements) which limited their spread.

DEPTH DISTRIBUTION

Although Fowler's work (1909) in the Bay of Biscay is marred (as pointed out by Skogsberg, 1920) by a number of taxonomic errors, it is still clear from his results that in a number of species of the Halocypridae there is a vertical nocturnal migration, and that each species has an optimum depth of occurrence in particular conditions. Certain species in the present series of samples occur in sufficient numbers to indicate similar results. A graphical representation of the depth distribution of the adults of these species is given in Figs 4 and 5. (These figures are corrected for the differing lengths of the column through which the nets were hauled.) In the case of *C. elegans* (Fig. 4) it is clear that the distribution of the species is centred around a depth of from 250 to 500 m. At Station WS 977 a large

number of specimens were found in the 50–0 m. sample, indicating a swarm of a part of the population near to the surface. This station was worked at night, while the neighbouring Stations WS 976 and 978, where this phenomenon is not found, were worked during the day. This then would indicate that a nocturnal migration to the surface might be taking place. Similarly at Station WS 986 and 996 in daytime the majority were at 250–500 m., while at WS 997 at night, though the catch was small, there is evidence of a movement towards the surface. Fowler (1909) does in fact show such a migration for this species.

C. nasotuberculata (Fig. 5) and *C. curta* (Fig. 4) also show a depth distribution centred about 500–250 m. or rather less, though, in the latter case, the numbers are only sufficient at Stations WS 976 and 996 to indicate this. The rise in numbers of *C. nasotuberculata* above 250 m. at Station WS 977 may indicate a vertical migration, but in neither species is there a clear indication of such a migration as in the case of *C. elegans*.

The numbers of *C. alata* were much smaller but as will be seen from the Appendix (pp. 276–8), the majority of those specimens captured were in the 500–250 and 750–500 m. samples. This indicates a distribution around a level of about 500 m., or rather deeper than in the case of the three species already considered.

C. teretivalvata occurred in moderately large numbers (Fig. 5). Here the indications are that this species is distributed around a depth of 250–100 m., or at a much less depth than the other species considered. A large number of adults of the species occurred in the 750–500 m. sample at Station WS 976, but on the basis of the data available no explanation can be offered for this. There are some indications of nocturnal migration to the surface at Station WS 977.

Some of the species such as *C. symmetrica* occur in large numbers at depths of 1000 m. or more; hence the small numbers of these species in the samples may be due to the absence of samples from depths of more than 1000 m. It seems that, at the time when the samples were taken, the majority of the species found in moderate numbers in the samples had a greatest density of population at depths between 250 and 750 m.

SUMMARY

The Ostracod material from samples collected by the 'William Scoresby' during a first survey of the Benguela current (March 1950) has been examined. Twenty-three species of the genus *Conchoecia* have been identified and numbers of adult males and females as well as juveniles determined for each species. Single juveniles of *Halocypris brevirostris* and a *Cypridina* sp. were also present.

Data regarding depth distribution obtained by means of closing-nets, together with morphological examination, has made it possible to conclude that the Ostracods described previously under the name *Conchoecia rotundata* Müller are probably three closely allied species. Two of these species present in the Benguela current have been re-named.

An almost complete absence of specimens has been noticed in samples taken over the Continental Shelf. This is in contrast to the presence of quite a number of specimens of several species in samples taken at similar depths at deeper water stations.

A few species were present in sufficient numbers to obtain indications of their depth distribution.

There is evidence of a nocturnal migration towards the surface in *C. elegans* Sars.

C. echinata Müller and *C. obtusata* Sars var. *antarctica* Müller have been found south and north of their previously known areas of distribution respectively.

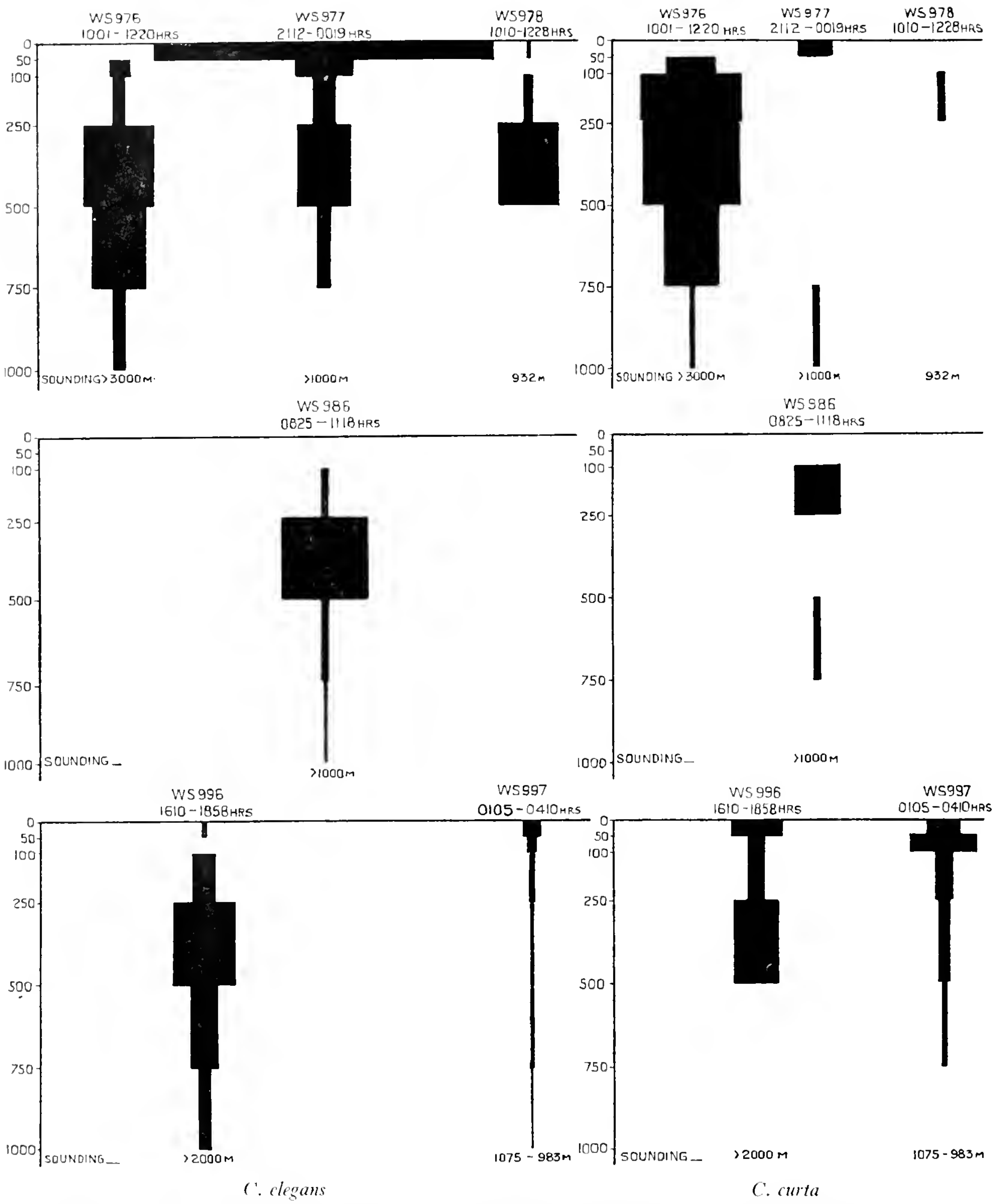

Fig. 4. Diagram to illustrate the depth distribution of *C. elegans* and *C. curta* on the basis of average numbers of adults of each species for each 50 m. of depth in each sample. The horizontal scale is the same for all diagrams of any one species but differs for different species.

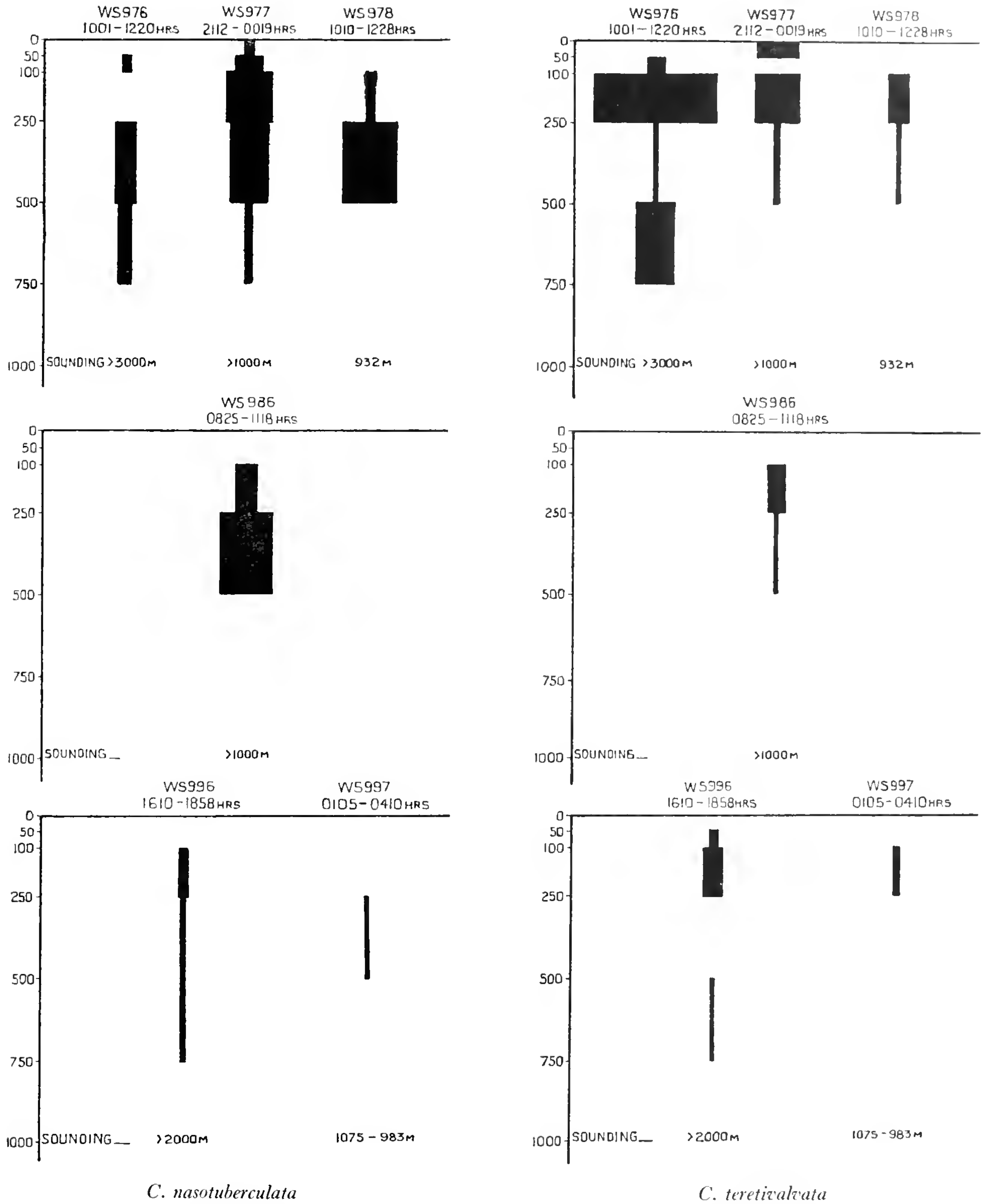

Fig. 5. Diagrams constructed as Fig. 4 to illustrate the depth distribution of *C. nasotuberculata* and *C. teretivalvata*.

APPENDIX

Station WS 976. Date 6. iii. 50. Position 22° 50′ S., 11° 38′ E. Time 1001–1220 hr. Sounding 3098 m. 50–0 m. sample contained no Ostracods.

	100–50 m.			250–100 m.			500–250 m.			750–500 m.			1000–750 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	0	0	0	0	9	0	8	5	4	10	2	0	0
C. bispinosa	0	0	0	1	0	3	3	5	10	8	3	6	0	0	0
C. curta	1	2	2	11	7	13	17	12	11	8	9	13	1	0	1
C. daphnoides	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
C. echinata	0	0	0	1	0	1	2	7	5	3	1	5	0	0	0
C. edentata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
C. elegans	4	1	0	8	0	0	59	26	40	45	21	15	13	0	0
C. haddoni	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
C. lophura	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
C. loricata	0	0	0	0	0	0	0	1	12	0	1	2	0	0	0
C. mamillata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C. nasotuberculata	1	0	2	0	0	0	9	3	28	1	7	22	0	0	0
C. obtusata	0	0	0	1	1	4	1	0	1	4	1	0	1	0	1
C. procera	0	0	0	0	0	1	1	3	1	0	0	4	0	0	0
C. skogsbergi	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0
C. spinifera	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
C. subarcuata	0	1	2	2	2	21	0	1	31	0	0	6	0	0	0
C. symmetrica	0	0	0	0	0	2	2	0	8	1	0	9	2	0	5
C. teretivalvata	2	0	2	26	19	9	2	0	2	19	5	4	0	0	0
Unidentified	0	0	3	0	0	48	0	0	90	0	0	123	0	0	20

Station WS 977. Date 6/7. iii. 50. Position 22° 39′ S., 12° 16′ E. Time 2112–0019 hr. Sounding 1970 m. nearby later.

	50–0 m.			100–50 m.			250–100 m.			500–250 m.			750–500 m.			1000–0 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	1	0	0	0	0	0	4	6	2	36	5	5	0	8	6	72
C. curta	2	0	2	0	0	4	0	0	1	0	0	0	0	0	0	0	2	4
C. echinata	0	0	0	1	0	0	0	0	0	2	1	1	1	0	0	2	2	4
C. elegans	50	33	46	7	7	6	7	8	24	37	27	55	15	1	1	120	104	258
C. loricata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	1
C. nasotuberculata	1	0	0	0	3	0	8	9	3	8	14	54	3	1	8	23	19	156
C. obtusata	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. procera	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
C. skogsbergi	0	0	0	0	0	0	0	0	0	4	3	2	0	0	0	3	2	2
C. subarcuata	0	0	0	0	1	0	1	0	8	0	2	3	0	0	0	1	1	10
C. symmetrica	0	0	0	0	0	0	0	0	0	1	0	1	0	0	9	2	2	10
C. teretivalvata	4	1	4	0	0	0	11	5	5	1	1	1	0	0	0	5	10	21
Unidentified	0	0	11	0	0	0	0	0	0	0	0	137	0	0	22	0	0	295

Station 978. Date 7. iii. 50. Position 22° 28′ S., 14° 42′ E. Time 1010–1228 hr. Sounding 932 m.

	50–0 m.			250–100 m.			500–250 m.			500–350 m.			750–500 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	0	1	1	0	7	2	29	4	4	17	8	0	0
C. curta	0	0	0	0	1	3	0	0	7	0	0	0	0	0	0
C. echinata	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0
C. elegans	0	1	0	4	2	1	52	19	62	16	8	6	0	0	1
C. loricata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
C. nasotuberculata	0	0	0	1	2	3	20	13	49	10	13	64	0	0	0
C. skogsbergi	0	0	0	0	0	0	3	2	1	4	0	2	0	0	0
C. subarcuata	0	0	0	1	0	1	0	2	3	0	0	0	0	0	1
C. symmetrica	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0
C. teretivalvata	0	0	0	5	2	4	2	0	2	0	0	0	0	0	0
Cypridina sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Unidentified	0	0	0	0	0	18	0	0	191	0	0	118	0	0	11

No Ostracods were found in the 100–50 m. sample.

Station 979. Date 7. iii. 50. Position 22° 47′ S., 13° 35′ E. Time 2225–2255 hr. Sounding 139 m. Samples taken at 50–0 and 100 to 50 m. contained no Ostracods.

Station 980. Date 8. iii. 50. Position 22° 44′ S., 14° 08′ E. Time 0255–0325 hr. Sounding 106 m. Sample taken 50–0 m. contained no Ostracods; the 100–50 m. sample contained a single female *C. teretivalvata*.

Station WS 981. Date 8. iii. 50. Position 22° 44′ S., 14° 20′ E. Time 0635–0701 hr. Sounding 64 m. A sample taken 50–0 m. contained no Ostracods.

Station WS 986. Date 10. iii. 50. Position 25° 15′ S., 13° 06′ E. Time 0825–1118 hr. Sounding > 1000 m.

	100–50 m.			250–100 m.			500–250 m.			750–500 m.			1000–750 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	0	0	1	9	1	0	68	1	0	0	1	0	0
C. bispinosa	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0
C. curta	0	0	2	4	4	21	0	0	0	2	0	1	0	0	2
C. daphnoides	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C. echinata	0	0	0	0	0	0	1	1	5	0	0	0	0	0	0
C. elegans	0	0	0	3	2	23	65	38	174	6	1	0	3	0	0
C. hirsuta	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
C. lophura	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
C. loricata	0	0	0	0	0	0	1	0	0	1	1	0	0	0	3
C. macromma	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C. nasotuberculata	0	0	0	6	1	3	15	17	51	0	0	0	0	0	0
C. skogsbergi	0	0	0	0	0	0	3	1	2	0	0	0	3	0	0
C. subarcuata	1	1	0	0	0	3	0	0	2	0	0	0	0	0	0
C. symmetrica	0	0	0	0	0	0	0	0	3	0	0	4	1	1	7
C. teretivalvata	0	0	0	5	1	10	1	0	2	0	0	0	0	0	0
Unidentified	0	0	0	0	0	5	0	0	70	0	0	8	0	0	8

The 50–0 m. sample contained no Ostracods.

Station WS 987. Date 10. iii. 50. Position 25° 13′ S., 13° 43′ E. Time 1822–1955 hr. Sounding 293 m. Samples taken 50–0, 100–50 and 250–100 m. contained no Ostracods.

Station WS 988. Date 11. iii. 50. Position 25° 12′ S., 14° 22′ E. Time 0035–0115 hr. Sounding 135 m. Samples taken 50–0 and 100–50 m. contained no Ostracods.

Station WS 989. Date 11. iii. 50. Position 25° 11′ S., 14° 39′ E. Time 0303–0322 hr. Sounding 70 m. A sample taken 50–0 m. contained no Ostracods.

Station WS 996. Date 12. iii. 50. Position 28° 41′ S., 13° 25′ E. Time 1610–1858 hr. No sounding.

	50–0 m.			100–50 m.			250–100 m.			500–250 m.			750–500 m.			1000–750 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	1	0	0	0	0	0	0	2	0	6	0	0	6	1	0	1
C. bispinosa	0	0	0	0	0	0	2	0	1	1	0	8	0	0	0	0	0	0
C. chuni	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C. curta	2	1	1	1	0	0	1	2	7	8	5	8	0	0	3	0	0	0
C. daphnoides	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
C. echinata	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
C. elegans	1	0	1	0	0	0	9	7	20	43	31	62	24	7	10	9	3	3
C. haddoni	0	0	0	0	0	0	0	0	0	4	0	1	2	1	0	1	0	0
C. lophura	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
C. loricata	0	0	0	0	0	0	0	0	0	1	0	4	0	0	3	0	0	0
C. mollis aff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C. nasotuberculata	0	0	0	0	0	0	0	3	0	0	3	2	0	3	2	0	0	0
C. obtusata	0	0	0	0	0	0	3	1	0	1	0	0	0	0	0	0	0	0
C. procera	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C. skogsbergi	0	0	0	0	0	0	1	0	0	0	0	0	1	0	2	0	0	2
C. spinifera	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
C. subarcuata	0	0	0	0	0	0	0	0	9	0	0	3	0	0	0	0	0	0
C. symmetrica	0	0	0	0	0	1	0	0	0	0	0	13	0	0	20	1	2	1
C. teretivalvata	0	0	0	1	0	0	2	5	1	0	0	0	0	1	0	0	0	0
Unidentified	0	0	3	0	0	3	0	0	43	0	0	76	0	0	36	0	0	10

Station WS 997. Date 13. iii. 50. Position 28° 40′ S., 14° 06′ E. Time 0105–0410 hr. Sounding 1075–983 m.

	50–0 m.			100–50 m.			250–100 m.			500–250 m.			750–500 m.			1000–750 m.		
	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.	♀	♂	juv.
C. alata	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0	0	0
C. bispinosa	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
C. curta	0	2	5	3	1	29	0	3	18	3	0	9	0	1	3	0	0	2
C. daphnoides	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
C. echinata	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
C. elegans	4	0	2	1	1	26	2	1	10	1	1	16	2	0	5	1	0	3
C. haddoni	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
C. lophura	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
C. loricata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
C. nasotuberculata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
C. obtusata	0	0	0	0	0	0	2	1	3	4	3	6	0	0	1	0	0	0
C. skogsbergi	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
C. subarcuata	0	0	3	0	0	3	1	0	3	0	0	3	1	0	1	1	0	0
C. symmetrica	0	0	0	0	0	0	0	0	0	1	0	2	1	0	2	2	1	2
C. teretivalvata	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Halocypris globosa	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Unidentified	0	0	0	0	0	3	0	0	4	0	0	29	0	0	42	0	0	7

Station WS 998. Date 13. iii. 50. Position 28° 40′ S., 14° 43′ E. Time 0810–0850 hr. Sounding 198 m. In the 50–0 m. sample there were no Ostracods. The 100–50 m. sample contained one juvenile not yet identified and the 175–100 m. sample contained one female *C. elegans*, one female and one juvenile *C. obtusata* and one male *C. teretivalvata*.

Station WS 999. Date 13. iii. 50. Position 28° 38′ S., 14° 49′ E. Time 1125–1200 hr. Sounding 171 m. Samples taken 50–0, 100–50 and 175–100 m. contained no Ostracods.

Station WS 1000. Date 13. iii. 50. Position 28° 40′ S., 15° 29′ E. Time 1940–2030 hr. Sounding 188 m. Samples taken 50–0, 100–50 and 150–100 m. contained no Ostracods.

Station WS 1001. Date 14. iii. 50. Position 28° 40′ S., 15° 56′ E. Time 0005–0140 hr. Sounding 121 m. A sample taken 50–0 m. contained no Ostracods. A 100–50 m. sample contained a single juvenile of *C. curta*.

Station WS 1002. Date 14. iii. 50. Position 28° 40′ S., 16° 14′ E. Time 0302–0330 hr. Sounding 69 m. Sample taken 50–0 m. contained no Ostracods.

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OPEN BOAT WHALING IN THE AZORES

THE HISTORY AND PRESENT METHODS OF A RELIC INDUSTRY

By

ROBERT CLARKE, M.A.

CONTENTS

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By Robert Clarke, M.A.

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(Plates XIII–XVIII, Text-figs. 1–7)

INTRODUCTION

The Azores or Western Islands comprise a volcanic group of nine islands lying around latitude 38° N. some 900 miles from Portugal and towards the middle of the North Atlantic (Fig. 1). The islands lie in three groups whose outriders are distant from each other about 100 miles, and the distance from Corvo in the Western Group to Santa Maria in the Eastern Group is nearly 400 miles (Fig. 3, p. 297). The archipelago is administered not as a colony but as an integral part of Portugal. For this reason, when reference is made in the present account to the mainland or its inhabitants, these are usually distinguished as 'continental Portugal' and the 'continental Portuguese'.

At present (1953) there are three Portuguese whaling centres in the North Atlantic (Fig. 1). Setubal on the mainland of Portugal conducted steam whaling for Fin and Sperm whales between 1925 and 1927, and in 1944 resumed operations from a fine new station. In the archipelago of the Azores and in Madeira the fishery is of a different kind and only Sperm whales are taken. Sperm whales are the largest of the Toothed whales: the male Sperm whale can grow to 60 ft. in length and the female to 39 ft.

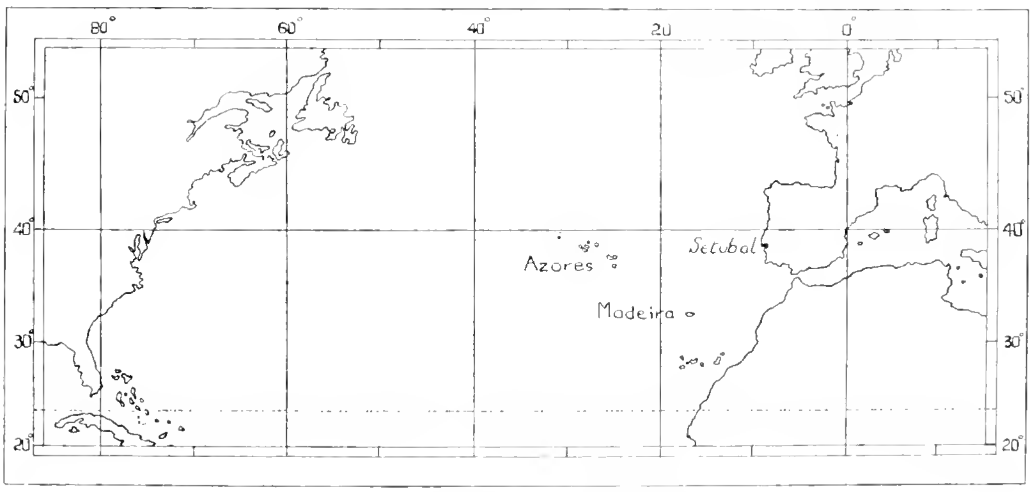

Fig. 1. Portuguese whaling centres in the North Atlantic in 1953. Open boat whaling is conducted from the Azores and from Madeira, and steam whaling from Setubal.

Sperm whaling in these islands is especially interesting because the methods employed are a survival of that old-time whaling generally believed to have quite vanished from the seas. Shore whaling off the coasts of the Azores, prosecuted with the hand harpoon and lance from open boats under oars or sails, is still a considerable industry. Moreover, these antiquated methods, learned from American whalers in the nineteenth century, are not confined to the chase, but extend at most places equally to the 'cutting in' of the whales and to the 'trying out' of their blubber in iron pots on the shore. An

'affair of oil' ashore at New Bedford in 1760, or even on a Spitzbergen beach in the early seventeenth century, must have been little different from a present-day scene in Pico or San Jorge or Terceira. It will indeed be seen that in four of the islands certain old 'try-works' stations have been replaced by

Table 1. *Sperm whales. Annual catches for the world and for the Azores from* 1910 *to* 1949

Year	Catch of whales: World	Azores	Azores (%)
1910	155	112	*72·3*
1911	302	120	*39·7*
1912	619	72	*11·6*
1913	465	68	*14·6*
1914	757	35	*4·6*
1915	861	33	*3·8*
1916	1083	71	*6·5*
1917	513	128	*24·9*
1918	1092	183	*16·8*
1919	1219	132	*10·8*
1920	873	124	*14·2*
1921	796	78	*9·8*
1922	912	121	*13·3*
1923	740	177	*23·9*
1924	950	71	*7·5*
1925	1475	151	*10·2*
1926	1775	199	*11·2*
1927	1441	166	*11·5*
1928	1989	185	*9·3*
1929	2074	212	*10·2*
1930	1311	99	*7·6*
1931	597	80	*13·4*
1932	811	179	*22·1*
1933	1423	266	*18·6*
1934	1999	234	*11·7*
1935	2481	379	*15·3*
1936	5068	387	*7·6*
1937	7392	417	*5·6*
1938	3725	417	*11·2*
1939	5049	400	*7·9*
1940	4466	552	*12·4*
1941	5303	(334)	—
1942	4383	525	*12·0*
1943	4538	663	*14·6*
1944	1466	591	*40·3*
1945	1382	443	*32·1*
1946	3418	592	*17·3*
1947	7395	565	*7·6*
1948	8766	698	*8·0*
1949	8728	484	*5·5*
1910–1949	99,792	10,743	*10·8*

This table has been prepared from the Azores catch figures in Table 10, and from world figures in the *Norsk Hvalfangsttid.* 1948, p. 312, and 1950, pp. 360, 560. The Antarctic catch figures are included in the year completing a southern summer season, for example, the world catch for 1949 includes the Antarctic catch for 1948–9. In the *Norsk Hvalfangsttid.* 1948, p. 312, figures were not available from 'Coast of Spain, Portugal and the Azores' for the earlier years 1910–19 and 1928–32; accordingly the Azores totals are added to the world catch in these years. Where the catch from 'Coast of Spain, Portugal and the Azores' has been shown as less than the actual Azores catch, there the world figures have been increased by the difference. For 1925–7 the Sperm whale catch from Setubal is added. These adjustments have made substantial changes in the published world catches of the earlier years, particularly 1910–23 when the changes would have been greater still had there been included the catches of the twenty or thirty Sperm whaleships still sailing in that period (see Table 3 and Plate XIII).

steam-powered factories, that since the turn of the century motor-boats have been generally used for towing purposes, and that in recent years radio-telephone has been introduced for communication between shore and motor-boat. Yet these are adjuncts rather than modifications, for the old Sperm whaling gear and the technique of hunting remain unchanged.

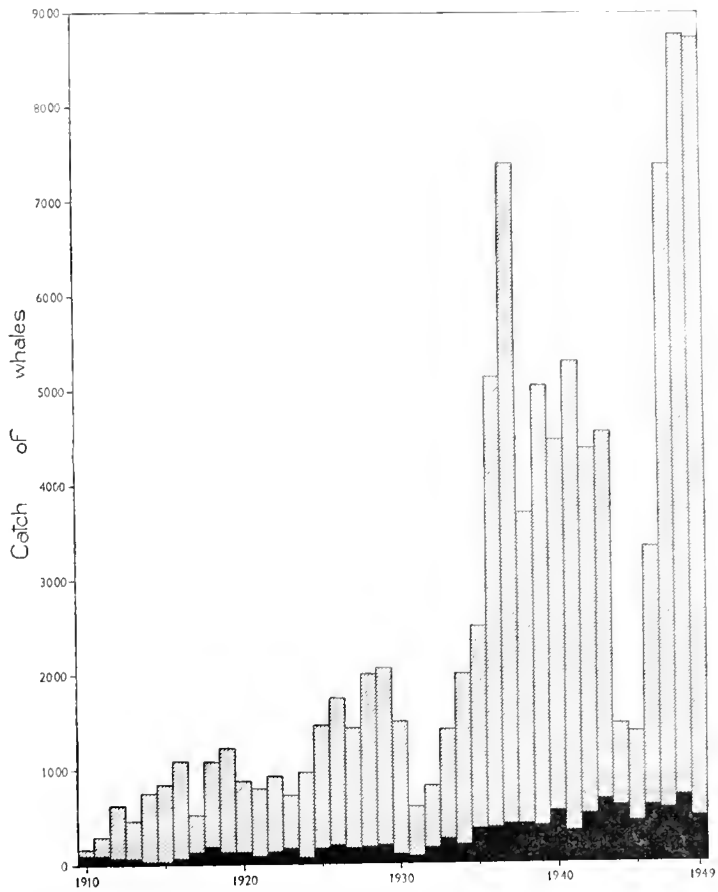

Fig. 2. Sperm whales. Annual catches for the world and for the Azores from 1910 to 1949.*

It is the more noteworthy therefore that the Azores open boat industry has never been so flourishing nor so widespread through the archipelago as it is today. Moreover, Table 1 and Fig. 2 show that, during 40 years of mechanized steam whaling elsewhere, the Azores contribution to the world catch of Sperm whales has never been negligible and was at one time substantial. Even in recent years, from 1946 to 1949, when post-war demands for sperm oil have been responsible for heavy catches by factory ships in the Antarctic and off Peru, the Azores have still managed to contribute between 6 and 17 per cent of the world catch.

The present report is an account of the origins, history and existing practice of open boat whaling in the Azores. It results from a mission undertaken in the summer of 1949 when I was sent to the Azores by the National Institute of Oceanography to investigate whales and whaling there. My stay lasted ten weeks, from 22 June to 5 September. During this period I visited all the nine islands and examined sixteen of the twenty-one whaling stations scattered through the archipelago (Fig. 3, p. 297; Table 4, p. 306). Although much of my time was spent in biological work on the island of Fayal, examining whale carcasses on the flensing platform at Porto Pim, Horta, I was privileged in August to sail after whales in the Fayal boats and make a 16-mm. cine-film which is believed to be a unique record of this survival.

* Azores figures for 1941 are incomplete.

The report has a historical and a technical section. To these are appended a few notes on Madeiran whaling which are necessarily sketchy and inadequate since I did not visit Madeira. The historical section falls naturally into two parts: the first describes the role of the Azores and their inhabitants in the pelagic Sperm whaling industry which the New Englanders inspired and monopolized during the eighteenth and nineteenth centuries; the second part traces from these whaleship days the emergence and subsequent fortunes of the shore whale fishery up to present times in the Azores. The technical section records the gear, methods and installations of the existing fishery and employs throughout comparisons with old-time American whaling. It says nothing of the effect of whaling on the stock of whales, because this is more appropriately included in a separate Discovery Report on Sperm whales which is nearing completion and which will examine the results of the biological work undertaken in 1949. This report will suggest that, although there is as yet no evidence of overfishing, it is unlikely that the stock would long withstand exploitation by steam whalecatchers, unless these were rigorously controlled.

Even though steam whaling may never be introduced into the Azores, I have been careful to make the technical record as detailed as my notes allow because it is too much to expect that an anachronism like this survival can continue indefinitely in an age whose mechanizing trend is everywhere withdrawing and protecting men from direct and manual conflict with the natural hazards of their environment. It is encouraging to know that in the North Atlantic men can still be found who have the courage and resolution, physical strength and endurance which open boat whaling demands.

ACKNOWLEDGMENTS

I am indebted to the Portuguese Government through its Ambassador in London, who approved my mission in 1949.

In recalling the goodwill and co-operation I met with everywhere, travelling in the Azores and in continental Portugal, I would especially like to thank the following persons for their great kindness with assistance or hospitality: Lieutenant-Colonel José Agostinho, Chief Meteorologist of the Azores; Senhor Joaquim Martins do Amaral, whaling owner of Fayal, at whose Porto Pim station I worked for two months; Senhor Tomas Alberto de Azevedo, manager of the Fayal whaleboats in which I sailed; Dr Tiberio avila Brazil, whaling owner in Pico; Capitão-Tenente Manuel Melo de Carvalho, Captain of the Port of Horta in 1949; Senhor Pedro Cimbron, whaling owner of San Miguel; Lieutenant-Commander Franklin Davies, R.N., the former British Vice-Consul in Porta Delgada; Dr J. Mousinho Figueiredo of the Ministry of Economics, Lisbon, an authority on Azores whaling; Senhor J. V. Leal of Pan American Airways System, Santa Maria; Commander J. W. McClelland, R.N., the British Naval Attaché at Lisbon in 1949; Senhor Jacinto Silviera de Medeiros, part-owner of the old try-house at Porto Pim, who has contributed much to the historical section of this account by patiently ransacking on my behalf the archives and newspaper files at Horta, by interviewing old whalemen in Fayal and Pico, and by providing photographs of the last years of the whaleships in the Azores; Senhor Manuel Neves who shares ownership of the Porto Pim try-house with Senhor Medeiros; Mr H. R. Pearce, the only British resident in Terceira; Dr Alfredo Magalhães Ramalho, the Director of the Marine Biological Institute in Lisbon, who has since helped with some Portuguese literature; Senhor Francisco Marcelino dos Reis, owner of the Setubal whaling station; Senhor José Tavares dos Reis, manager of the whaling factory at Porto Pim, whose special help in the biological work will be acknowledged in a separate report; Senhor Antonio Linnares dos Santos, whaling owner of Terceira; and Senhor José Cristiano de Souza, whaling owner in Pico. In this list of helpers overseas, I have purposely left till last my best thanks to Mr B. L. Collins, of Horta, until recently British

Consular Agent, a friend who has been untiring with ways to meet my many requests no less since I left the islands than when he warmly supported my mission in 1949.

At home I thank Dr F. C. Fraser, of the Natural History Museum, who has kindly read this account in manuscript and who first told me, after his return from the voyage of the *Atlantide* (p. 305), that open boat whaling still survives in the Azores. Finally I am especially grateful to Dr N. A. Mackintosh, C.B.E., for sending me on this mission, for his advice and encouragement during the preparation of this report, and for seeing it through the press during my absence overseas.

THE HISTORY OF WHALING IN THE AZORES

The historical material does not pretend to be exhaustive. Early records are fragmentary or deficient, although I have been most fortunate in the special local assistance given by Senhor Jacinto Silviera de Medeiros. The whaling statistics in the Appendix (Table 10) are from the *Estatistica das Pescas Maritimas no continente e ilhas adjacentes*, an official compilation of all Portuguese fisheries statistics, which is published annually. Its whaling records go back to 1896, and no earlier statistics are available to me, except for some isolated figures for the Western Group 1886-90, given by Faria e Silva (1890). The *Estatistica das Pescas* contains certain other notes on whaling material which I have found useful. Otherwise my sources are scattered references in the narratives of Sperm whaling voyages and in the Portuguese literature: a more ambitious account would have required perusal of the State Papers of Portugal and a visit to the unique whaling libraries of New England.

The whaleships. 1765–1921

The hunting of Sperm whales on any commercial scale around the Azores was not at first undertaken from the shore, but from the lowered boats of whaleships. Such cruising in the Azorean seas, called by whalemen the 'Western Islands ground', continued to the very last days of the deep-sea industry; and shore whaling—established no earlier than the 1830's—did not become a serious competitor for the local stock of whales until the end of the century. It seems that an occasional whale was captured before the coming of the New England whaleships (p. 296), but the history of the shore fishery properly begins with those Azores islanders who got their skill in these vessels and afterwards took the American methods ashore, where, staying at home, they could still hunt from their steep volcanic coasts the whale whose deep-water habit had previously led them to join protracted voyages into every ocean of the world.

The commencement of Sperm whaling from the ports of New England has been well chronicled by Macy (1835), Scammon (1874) and Starbuck (1878). By 1738 there had become established the practice of fitting out vessels 'to whale out in the deep for Sperm whales', and the whalers pushed farther and farther into the Atlantic Ocean, successively discovering new and lucrative cruising grounds. Sperm whales were hunted off the Carolina coast, then off the Bahamas and West Indies and in the Gulf of Mexico and the Caribbean Sea. Venturing eastward the whalers opened up the coast of Guinea in 1763, the Azores ground in 1765, and afterwards and more southerly, the coast of Brazil in 1774 (Macy, 1835).

Soon after it was first exploited in 1765, the Western Islands ground became a profitable fishery. Starbuck records that Nantucket whaleships in 1768 made a voyage to the Azores and by the middle of September had obtained an average of 150 barrels for each ship. This season, impressive by the standards of those days, is reported by D. Antão de Almada, Governor and Captain-General of the Azores, in a letter dated 19 October 1768 to the minister Francisco Furtado. Chaves (1924*a*) quotes from Almada's letter that in this year there had been 200 English (*sic*) ships fishing in the latitude of the islands, and they had each taken an average of 250 barrels of sperm oil and 100 barrels of spermaceti.

Other historians mention this letter. Serpa (1886, p. 24) and Lima (1940, p. 391) give much the same rendering although Lima mentions a previous season, 1767. But their excerpts maintain a confusion between whaleships and whaleboats, for Faria e Silva (1890, p. 541) gives the fishing strength not as 200 ships but as 70 ships working 200 whaleboats, and altogether producing 20,000 barrels of sperm oil and a great quantity of spermaceti. Actually the Nantucket fleet numbered 125 vessels, averaging 75 tons burden, in 1768 (Starbuck, 1878, p. 174); some of these went north, so that 70 is a reasonable estimate for those cruising off the Azores, but the total production for all Nantucket vessels in that year was only 15,439 barrels, which makes Almada's production figures too high.

English whalers at this time were occupied solely in the Greenland whale fishery, and by 'English ships' Almada meant the New England whalers, for North America was still a British possession at that date. It is undisputed that the American colonists had the initiative as well as the monopoly in the great Sperm whaling enterprise. Although later Britain was to be first after Sperm whales in the Pacific, she did not enter the fishery for this whale until 1775 (Beale, 1839, p. 143).

The catches to be made at the Western Islands were so good that whalers continued to frequent them in spite of the depredations of French and Spanish privateers and pirates which infested the whaling ground about the year 1770 (Starbuck, 1878, p. 53). By the end of the eighteenth century visits to the Azores and cruises in the adjacent seas had become a customary part of Atlantic whaling voyages. This practice persisted when the whaleships began to go farther afield, voyaging into the Indian Ocean (first opened for Sperm whaling on the Madagascar grounds in 1789) and into the Pacific which was rapidly exploited after the return of the British whaleship *Amelia** in 1790. As the nineteenth century progressed the Sperm whalers were increasingly attracted towards these oceans, and the duration of their voyages was prolonged into years. But most of these southseamen included some weeks or months in the North Atlantic cruising on the Western Islands or the Cape Verde grounds, either at the beginning of a voyage, or on the way home to New England in the hope of topping up a ship not quite full. Drouët, writing in 1861, states simply that all whaleships on their way to more southerly grounds fished between America, Bermuda and the Azores, but specially round the Azores, which were noted for large whales.

Calls at these islands, and the cruising off them, are features of the published narratives of most whaling voyages. Olmsted (1841) writes that the bark *North America* called at Fayal in 1839 at the beginning of a South Sea voyage. J. R. Browne (1846) describes how the bark *Styx*† took in the Azores on the way to Zanzibar. Bullen (1901) cruised off the Cape Verdes before going on to Mozambique, and Haley (1950, posthumous) visited both the Azores and the Cape Verdes in 1849 when bound for Australian grounds. Ferguson (1936, posthumous) mentions that the bark *Kathleen* called at the Azores in 1880, and having spent some time cruising there, sailed for the Gibraltar and Cape Verde grounds, afterwards returning to the Azores to tranship what oil she had taken before starting for Madagascar. The *Kathleen* was at the Azores again in 1900 (Table 2), but within two years was to be rammed and sunk by a Sperm whale on the Twelve Forty ground in the tropical Atlantic. Almost a century earlier, in 1807, the ship *Union* of Nantucket had met a similar end, and it was for Flores in the Western Azores that the survivors from that whale-struck ship had set their course (Starbuck, 1878, p. 115). In the nineties Chippendale (1953) was several times in the Azores or cruising off them, notably in the barks *Canton* and *Sunbeam*. Ashley (1926), who sailed in the *Sunbeam* in 1904, cruised the Western Islands and Canaries grounds at the start of a voyage to the West Coast of Africa and the South Indian Ocean. Finally may be mentioned the *Ocean Rover* which took in the Azores to fill her

* *Amelia* is the usual spelling in the nineteenth-century literature, but according to Dakin (1934) the correct spelling is *Emelia*.

† *Styx* seems to be a fictitious name for the vessel in which Browne sailed as a foremast hand.

empty casks on the way home after a long voyage and thereby gave rise to a famous incident of the American Civil War. When three years and four months out from New Bedford she was captured and burned off Flores by the Confederate cruiser *Alabama*. According to Starbuck (1878, p. 101) the blazing vessel attracted other whaleships to her assistance, and in this way the *Alabama* destroyed eight more Yankee whaling vessels: but Semmes, commanding the *Alabama*, said he had no choice but to burn the ships and did not in fact use them as lures for others (Semmes, 1869, pp. 423 ff.).

Beside these subsidiary cruises near home by the southseamen, there were vessels called 'plum-puddingers', mostly schooners and small brigs, which commonly frequented the Azores. The ''tween seasons' or plumpudding voyages were short, usually of not more than six months duration, and confined to cruising grounds in the North Atlantic at a time when Sperm whaling voyages, mainly in other seas, commonly lasted for three or four years (Melville, 1851, p. 95; Scammon, 1874, p. 241; Ashley, 1926, p. 103; Hohman, 1928, p. 9). The port which specialized in plumpudding voyages was Provincetown, Mass., and Captain N. E. Atwood (in Clark, 1887, p. 144) records that from 1820 onwards the Azores were a favourite ground for Provincetown vessels. By the middle of the century there were about 100 vessels, plumpuddingers and southseamen varying from 100 to 400 tons burden, cruising annually on the Western Islands ground (Drouët, 1861; Faria e Silva, 1890). According to Wilkes (1845, v, p. 520) the ground did not extend more than 200 miles from the islands and lay principally to the south of them. Apart from a little winter whaling the season lasted from April to November and Drouët states that the annual catch was about 150 whales, although this is a small figure for such a fleet and does not compare with the catches of the present shore fishery carried on by similar methods (Table 10).

When the Azores and the Cape Verdes were established as cruising grounds, it became the practice to call at the islands and embark the Portuguese inhabitants as recruits for the fishery. The whaleships also took fresh provisions from the Azores and salt from the Cape Verde Islands (Webster, 1834, p. 18).

Of the Cape Verdes it may be said that comparatively few islanders were recruited in the early decades: but in the last days of deep-sea whaling, between 1900 and 1920, when scarcely any nationals were to be found in the forecastles of American whaleships, these 'bravas' formed the major proportion of crews made up for the remainder of West Indians with some Azoreans. Murphy (1947), who made a whaling and sealing voyage in the brig *Daisy* in 1912–13, describes such a crew. The brigantine *Viola* called at the Cape Verde Islands for all her foremast hands in 1910 (Cook, 1926, p. 338). But I can find no reference to any shore whaling from the Cape Verdes although Sperm whales certainly frequent the islands, at least in winter. It appears that the bravas as whalemen passed with the whaleships.

The islands commonly visited in the Azores were Fayal, Flores, San Miguel and Terceira. Fayal was the most important because, according to Drouët, it originally provided better victuals than were obtainable elsewhere. Its connexion with the whaling trade quickly prospered: Lima (1940) records that 104 out of 327 vessels calling at Fayal in 1866 were whaleships. A remark by Olmsted (1841) shows that by 1839 there was a United States consul appointed at Horta to look after American whaling interests. It was this consul or his son who had a hand in developing the shore whale fishery (p. 296). The whalers called at Fayal not only for recruits and provisions but also to discharge and tranship sperm oil (Clark, 1887, p. 25; Chippendale, 1953, p. 62). Drouët notes that every year four or five thousand barrels of oil were transhipped at the port of Horta. In those days the harbour had no breakwater and was dangerously exposed to storms and swell. Some of the transhipment trade was shifted to San Miguel when a new port was constructed at Ponta Delgada. Swindells, quoting in 1877 from a pamphlet by the harbour engineer of Ponta Delgada, wrote: 'lately St Michaels tends to become the entrepot where American whalers tranship or discharge their oil'. But the importance of San

Table 2. *Register of Sperm whaling vessels calling at Horta, Fayal, between 1900 and 1921. Compiled by Senhor Jacinto Silviera de Medeiros*

Date		Name	Rig	Port of Registry	Remarks
1900	26 Aug.	*Pedro Varela*	Schooner	New Bedford	Captain Joao Pereira de Freitas
	27	*Greyhound*	Bark	New Bedford	Captain M. E. Costa, native of Fayal. See also Chippendale, 1953
	28	*A. R. Tucker*	Bark		138 tons burden
		Pearl Nelson	Schooner		—
	3 Sept.	*Swallow*	Bark		Provision and oil transport
	8	*Platina*	Bark		—
	12	*Kathleen*	Bark	New Bedford	See p. 288
	22	*President*	Bark	—	
	14 Oct.	*Morning Star*	Bark	New Bedford	
1901	8 May	*Joseph Manta*	Schooner		Captain Antonio José de Freitas, native of Flores
	24 Aug.	*Joseph Manta*			—
	25	*Pedro Varela*	Schooner	New Bedford	—
	31	*Harry Smith*	Brigantine	—	Provision and oil transport
		Mary E. Simmons	Schooner		—
	1 Sept.	*Sunbeam*	Bark	New Bedford	Wrecked off Sapelo Island, Georgia, 1911 (see Ashley, 1926; Chippendale, 1953)
	9	*Platina*	Bark		—
	12	*Greyhound*	Bark	New Bedford	
	18	*President*	Bark	—	
		Canton	Bark	New Bedford	Later sold as a Brava packet and lost in the Cape Verde Islands (see Chippendale, 1953)
	20	*Pearl Nelson*	Schooner		—
	25	*Ellen A. Swift*	Schooner	—	—
1902	25 Aug.	*Harry Smith*	Brigantine		
	31	*Eleanor B. Conwell*	Schooner	New Bedford	
	2 Sept.	*Platina*	Bark	—	
	3	*President*	Bark		
		Sunbeam	Bark	New Bedford	
	5	*Bertha*	Bark	New Bedford	Sold to Portugal as a packet in 1917 and lost at sea 1918 (see Robotti, 1950, p. 136)
		A. R. Tucker	Bark		
	9	*Golden City*	Schooner		
	15	*Morning Star*	Bark	New Bedford	
1903	22 Aug.	*Joseph Manta*	Schooner		Lost with all hands in a hurricane off Fayal, 9 October 1903
	25	*Harry Smith*	Brigantine		—
	27	*Adelia Chase*	Schooner		
	1 Sept.	*Pedro Varela*	Schooner	New Bedford	
		Bertha	Bark	New Bedford	
	2	*Greyhound*	Bark	New Bedford	
	8	*Eleanor B. Conwell*	Schooner	New Bedford	
	11	*Mary E. Simmons*	Schooner		
		Canton	Bark		
	14	*Sunbeam*	Bark	New Bedford	
	15	*Ellen B. Swift*	Schooner	—	
		Morning Star	Bark	New Bedford	—
	2 Nov.	*President*	Bark	—	—
1904	14 Aug.	*Harry Smith*	Brigantine	—	
	28	*Greyhound*	Bark	New Bedford	
	2 Sept.	*Pedro Varela*	Schooner	New Bedford	
	7	*John R. Manta*	Schooner	Provincetown, Mass.	See p. 305. Registered in New Bedford sometime after 1904
	10	*Leonora*	Brigantine		
	16	*Platina*	Bark		
	19	*A. R. Tucker*	Bark	—	
		Morning Star	Bark	New Bedford	
1905	18 Aug.	*Pedro Varela*	Schooner	New Bedford	
	20	*Harry Smith*	Brigantine		
	21	*A. R. Tucker*	Bark		
	29	*Bertha*	Bark	New Bedford	

Table 2 (*continued*)

Date		Name	Rig	Port of Registry	Remarks
1905	6 Sept.	*Greyhound*	Bark	New Bedford	—
		Wanderer	Bark	New Bedford	See p. 292
	8	*Canton*	Bark	—	
	9	*Sunbeam*	Bark	New Bedford	
	10	*Platina*	Bark	—	—
	20	*Leonora*	Brigantine	—	—
	21	*Sullivan*	Brigantine	Somerset, Mass.	Lost in Horta Bay, 14 October 1913
1906	31 Aug.	*Eleanor B. Conwell*	Schooner	New Bedford	—
		Greyhound	Bark	New Bedford	—
	1 Sept.	*Bertha D. Nickerson*	Schooner	—	—
	2	*Bertha*	Bark	New Bedford	—
		Frederick Roessner	3-mast schooner	—	Provision and oil transport
	3	*Morning Star*	Bark	New Bedford	—
1907	19 Sept.	*Greyhound*	Bark	New Bedford	—
1908	7 July	*Planet*	Steamship	*British*	Captain Thomas Gibson
	21 Sept.	*T. Towner*	Schooner	New Bedford	—
1910	31 July	*Pedro Varela*	Schooner	New Bedford	Put in for repairs after a mutiny
	30 Aug.	*Bertha D. Nickerson*[3]	Schooner	—	—
	3 Sept.	*Viola*[2]	Brigantine	Portland, Maine	Captain and owner John A. Cook (see Cook, 1926, p. 338). Reported missing 1918 under Captain José Luiz, native of Fayal
		Cameo[4]	Schooner	New Bedford	—
	5	*Pedro Varela*[5]	Schooner	New Bedford	—
		Richard W. Clark[1]	3-mast schooner	New Bedford	Provision and oil transport
	10	*Carleton Bell*[6]	Schooner	New Bedford	—
		T. Towner[7]	Schooner	New Bedford	—
		Bertha[8]	Bark	New Bedford	—
		Morning Star[9]	Bark	New Bedford	—
	11	*Wanderer*[10]	Bark	New Bedford	—
	14	*John R. Manta*[11]	Schooner	Provincetown, Mass.	—
1911	28 Aug.	*Wanderer*	Bark	New Bedford	—
	30	*Margarett*	Schooner	New Bedford	See p. 305
	1 Sept.	*Richard W. Clark*	3-mast schooner	New Bedford	—
	7	*Viola*	Brigantine	Portland, Maine	Second year of maiden voyage under Captain John A. Cook
	8	*Pedro Varela*	Schooner	New Bedford	—
	10	*Greyhound*	Bark	New Bedford	—
		Alice Knowles	Bark	New Bedford	302·78 tons. Lost off Bermuda 1917 (see Chippendale, 1953)
		Andrew Hicks	Bark	New Bedford	—
	14	*A. E. Whyland*	Schooner	New Bedford	—
	15	*Charles W. Morgan*	Bark	New Bedford	Last surviving whaler, preserved (ship-rigged) as a memorial at Round Hills, New Bedford, 1925, and moved to Mystic, Connecticut, 1941
	15	*Valkyria*	Schooner	New Bedford	—
		Mystic	3-mast schooner	New Bedford	—
	2 Oct.	*Morning Star*	Bark	New Bedford	—
1912	28 Aug.	*T. Towner*	Schooner	New Bedford	
	5 Sept.	*Richard W. Clark*	3-mast schooner	New Bedford	
		Carelton Bell	Schooner	New Bedford	
		John R. Manta	Schooner	Provincetown, Mass.	
	6	*Alice Knowles*	Bark	New Bedford	
	9	*Mystic*	3-mast schooner	New Bedford	
	9	*Bertha*	Bark	New Bedford	
	19	*Wanderer*	Bark	New Bedford	—
	22	*Cameo*	Schooner	New Bedford	
	28	*A. E. Whyland*	Schooner	New Bedford	
1913	27 Aug.	*Carelton Bell*	Schooner	New Bedford	
	31	*Greyhound*	Bark	New Bedford	
	9 Sept.	*Mystic*	3-mast schooner	New Bedford	—
	11	*Edward R. Smith*	3-mast schooner	Boston, Mass.	Provision and oil transport
	12	*Cameo*	Schooner	New Bedford	
	16	*Andrew Hicks*	Bark	New Bedford	—
	17	*Morning Star*	Bark	New Bedford	—
	20	*Sullivan*	Brigantine	Somerset, Mass.	—
1921	11 Dec.	*Athlete*	Schooner	—	Captain Lester Mosher

[1–11] These index figures identify the vessels shown in Plate XIII in September 1910.

Miguel did not last, for Horta also got its breakwater and (except for some competition from Dominica and Las Palmas in the final decade 1910–20) retained its standing as a premier port for transhipment and provisioning right to the lingering end of the old-time whaling. This is strikingly shown in Table 2, a register of whaleships and their associated provision and oil transports which called at Horta between 1900 and 1921. This table, except for a few added remarks, has been compiled by Senhor Jacinto Silviera de Medeiros. All the vessels wore the American flag except the British *Planet*. They include most of the whalers still sailing in those last years, and several of them (some already mentioned in this account) were famous in whaling history. September was the season when the whaleships assembled at Horta, and the remarkable photograph reproduced in Plate XIII shows that even as late as 1910 the harbour could present a lively prospect of sails, crossed spars and hoisted boats. Ships in the register for 1910 can be identified in Plate XIII, for Senhor Medeiros, who provided this photograph,* has also been able to name the vessels. The bark *Wanderer* and the schooner *John R. Manta* were later to be the last vessels to clear for Sperm whaling. The *Wanderer* was wrecked with the voyage scarcely begun outside New Bedford harbour at Cuttyhunk on 26 August 1924. In the following year the *John R. Manta* made a voyage from New Bedford to the Hatteras ground. With her return, and the return of the schooner *Margarett* also in 1925 from a longer cruise, the old-time whaling voyages were ended (Ashley, 1926, p. 117; Tripp, 1938). The brigantine *Viola*, on her maiden voyage when the photograph in Plate XIII was taken, was the last vessel designed and built specially as a Sperm whaler. Famous for her graceful lines, the *Viola* made four Atlantic voyages, each time taking in the Azores ground, until in September 1918 she sailed for a fifth but was never seen again. On this tragic voyage her captain was an Azores islander, Joseph Lewis (José Luiz) of Horta (Cook, 1926, pp. 338 ff.; Medeiros, unpublished).

The islanders from the first showed themselves able recruits to the industry, and quickly learned the special skills and methods of Sperm whaling. All those authors whose narratives I have mentioned commend the readiness and proficiency of the Azoreans, not so much as seamen, but as look-outs, boatmen and harponeers—properly, that is, as whalemen. Ashley (1926, p. 5) has explained this success of the islander in whaling: 'Being nearly all islanders, brought up from childhood with oars in their hands, they were eminently suited to the purpose; for boatmen, not seamen, are required in the whale fishery.'

By the 1840's, when the American fishery was at its peak, the writings of Olmsted (1841), J. R. Browne (1846), Cheever (1851) and Melville (1851) show that the Azores whalemen were established as part of the Sperm whaling scene. Even in 1839 the *North America* had six 'Portuguese' in her total ship's complement of thirty-one (Olmsted, 1841) and in 1846 Browne records that when the *Styx* cleared from the Azores she had twice as many Azores sailors as Americans in her forecastle. A passage written about 1855 summarizes the islanders' position in American whaling in the mid-century (Nordhoff, 1941, p. 209, posthumous):

> A great many Western Island Portuguese find employment in American whalemen (*sic*), almost every vessel sailing from New Bedford carrying more or less of them. They are a quiet, peaceful, inoffensive people, sober and industrious, penurious, almost to a fault, and I believe invariably excellent whalemen.

Writing in 1861, Drouët said that most of the young men in the Azores chose to ship as whalemen if they could. A decade or so later, when the fishery had declined, the Azoreans bulked larger even than before, and some sailed as officers in the whaleships.

I am not here concerned with the causes of the decline of Sperm whaling; these have been variously analysed by Starbuck (1878, p. 113), Hohman (1928, chs. XIII and XIV), Harmer (1928, pp. 63–4) and Brandt (1940, ch. XIV). What is important to the present study is that the Portuguese, either Azoreans

* Taken by Senhor Goulart of Horta.

or the colonial Cape Verders, were prepared to put up with the hard conditions then prevailing in the whaleships: with indifferent food and low pay and inadequate sailing agreements, and with voyages that grew longer and longer during the several decades of the decline. Between voyages many settled in New England, for here the Azores expatriates, remarkable for their thrift and their warm regard for their native islands, could still manage to send money to dependents at home. Domiciled abroad, or at sea in the whaleships, they could also avoid the military conscription to which all Portuguese, unless they paid in lieu a good sum of money, were liable until their 36th year (Walker, 1886, p. 112). By 1880 a third of the 3896 whalemen in the New Bedford fleet were Portuguese, and the Azores islanders amongst them had so far established themselves in New Bedford that the section of the city where they lived was called Fayal (Brown, 1887, p. 218). New Bedford was the last port to fit out the old whaleships, and in 1949 I met two veteran whalemen, one in Santa Maria and one in Fayal, who had lived in New Bedford in their youth and had sailed after Sperm whales from that port. Both were still active as motor-launch enginemen in their shore fishery.

In the last phase of deep-sea whaling, between 1900 and 1920, the Azores islanders enjoyed their greatest influence in New Bedford ships, not so much in the forecastles (where berths were predominantly occupied by Cape Verders and West Indians), but on the quarter-deck where natives of Fayal and Flores and Pico commonly made voyages as mates, and sometimes as masters. Four ships recorded in Table 2 were commanded by Azoreans. The whaling voyage had by then reverted to the short Atlantic cruise favoured by the plumpuddingers and the earlier whalers of the late eighteenth century. On these short cruises and with slender and thrifty outfits, the Azores captains and part-owners could still make a whaleship pay even in the years between 1900 and the First World War, when the market for sperm oil had become quite limited. After 1921, however, it appears from Table 2 that no whaling vessel called at Fayal, and so far as the Western Islands ground was concerned this year saw the end of the whaleship era.

The technical section of this account will attempt to show how the Azores whalemen have retained the American tradition in the use of whaleboats, boat gear, and whaling implements. But in the ordinary conversation of the whalemen themselves lies a no less striking reminder of the origins of their fishery. These men speak only Portuguese, but they have preserved from their forebears some English words learned during the deep-sea voyages and representing the special vocabulary of their trade. Ancient terms which elsewhere live only in the pages of old narratives can be heard in the Azores today, sprinkling the Portuguese conversation of the whaleboat and the flensing platform. Chaves (1924*b*) and Figueiredo (1946) give some of these survivals of language, and I have overheard several others from the whalemen. They are collected in Table 3.

This glossary includes some of the more technical whaling terms, which will be explained in their appropriate places. The Portuguese spellings of these Azores identities are virtually phonetic renderings of the English words. Where equivalents in continental Portuguese exist they have been inserted, but some of these are not precise, and such approximations have been queried. Several of the terms, like 'blackskin', 'junk', 'case', 'short-warp' and 'loggerhead', have no corresponding expression in Portuguese; and there are others where the Portuguese equivalents exist, yet are not used by the whalemen or may not be known to them. 'Stern-oar' is such a word: its correct Portuguese rendering, *esparella* or *remo de esparella*, is not in their vocabulary. There are three words, common in the fishery, which have not been inserted in the table since they are currently in use on the continent, as in the Azores. They are 'harpoon' (*harpão, arpão*), 'lance' (*lança*) and 'motor-launch' (*gasolin-lancha*). 'Harpoon' of course owes nothing to America, and indeed antedates the discovery of the New World; this word, appropriately enough for the symbol of all whaling, is derived from the 'arpoi' of the early Basques (Markham, 1881, p. 974). A curious feature of the glossary in Table 3 is that, although it

includes English names for several species of whales, none the less the English generic word of their fishery is unknown to the islanders: a 'whale' to them is *baleia*, and by this term they mean, not any whale, but the Sperm whale, the only species they systematically hunt; they only say *Cachalote* when distinguishing the Sperm whale from other species.

The knowledge and experience gained by the Azores islanders in American ships was first put to use in the service of independent national enterprise, not in shore whaling from their own coasts, but in Portuguese whaling ventures on the seas adjacent to the colonial possessions of Portugal. The ships of the American whale fishery did not touch at the coast of Portugal, and no skilled whaling tradition

Table 3. *Glossary of whaling terms in English, currently used by Azores whalemen, and derived from the Americans*

English	Portuguese	
	Azores	Continental
Of the species of whales:		
Finback (*Balaenoptera physalus*)	Finebeque	Rorqual Comum
Humpback (*Megaptera novaeangliae*)	Ampebeque	Baleia de Bossa?
Bottlenose (*Hyperoodon ampullatus*)	Bôto	Bico de Garrafa
Killer } (*Orcinus orca*)	Quilha }	Roaz de bandeira
Grampus } (*Orcinus orca*)	Grampas }	Roaz de bandeira
Blackfish (*Globicephala melaena*)	Blequefich	?
Of the whale:		
bull	bulo	macho?
calf	cafe	baleia que ainda mama
blackskin	blequesquine	pelle
hump	ampo	bossa?
case	queize, caîse, coîce	—
junk	janco	—
spout	espato, esparto	coluna expiratoria, bufo, espirro
(there she) blows!	bloz!	—
Of the whaleboat:		
loggerhead	logaête, logaiéte	—
cleat	clit	gancho da enxarcia
boom (of mainsail)	bûme	botaló
oar	ôa, ór	remo
stern-oar	stanó, estanol	esparella, remo de esparella
short-warp	chote-ope	—
bomb-lance	bomblanço	—
Of cutting in and trying out:		
spade	espeide	—
(horse-)pieces	piças	troços, pedaços de toucinho?
try-works	traiol	—
cooler	cula	vaso para esfriar?

was ever properly established among the continental Portuguese. It is true that shore whaling in Portugal was a recognized fishery by the reign of D. Pedro I (1357–67), but Lopes (1938) points out that this whaling was prosecuted entirely by the Basques, who during the fourteenth and fifteenth centuries obtained leave to extend their hunt for Right whales from the Bay of Biscay southward to the coasts of Spain and Portugal. The continental Portuguese themselves had no appetite for whaling, and there was little or no response to the various protective concessions by which the sovereigns of Portugal hoped to encourage their nationals. By the end of the eighteenth century, however, the Azores islanders had become proficient in Sperm whaling, and the prospects of their employment in Portuguese ships gave renewed encouragement to those who wished to see a national enterprise competing with America and Britain in the sperm oil industry.

Starbuck, in a footnote (1878, p. 85), reports that the English statesman Pitt in 1785 said, 'the Portuguese had now...a very pretty spermaceti-whale fishery, which they had learned from the New Englanders, and carried on upon the coast of Brazil'. The Brazil ground had been established for Sperm whaling in 1774, the business being prosecuted from whaleships well off the coast. Continental Portugal furnished the ships and finance for its venture on this whaling ground but the whalemen concerned were undoubtedly islanders from the Azores, possibly with some Cape Verders. The attraction of the Azores whaleman to the Brazil enterprise may be partially considered as an aspect of the long (and still surviving) tradition of emigration from the Azores to Brazil. This new Portuguese whaling seemed to prosper at first, and efforts were made to exploit other grounds. Lopes records that in 1798 D. Maria I, Queen of Portugal, raised a fleet to hunt whales and try out oil at sea along the coasts of Portugal, Brazil, Mozambique and the Cape Verdes. In later decades there were bounties, like those offered at that time by the English government, for whaling ventures to the South Seas. Two of these subsidized Portuguese voyages were those of the *Speculacão* and the *Adventeur* to New Zealand in 1840 (McNab, 1913, p. 288). But the deep-sea industry never became established, and it seems that by the 1860's the Portuguese whaleships were reduced to a few which cruised the Azores ground in summer (Drouët).

Some of these few ships were not from the Portuguese mainland, for, according to Faria e Silva and Lima, the Azores islanders in 1875 themselves began to fit out vessels for the off-shore ventures. The first was a French brig abandoned by the assurance company because of her poor condition: a company was formed in Fayal to prepare her for whaling as the *Cidade da Horta*. Most likely she was the 'Portuguese whaling brig' which the cruiser *Alabama*, between the taking of the *Starlight* and the *Ocean Rover*, chased off Flores in 1862, mistaking her for a Federal whaler (Semmes, 1869, p. 431). Faria e Silva says there were never more than five local whaling vessels, but Macedo (1871, II, p. 281) claims that Horta could at one time boast ten whaleships of her own. However, there was little money available in the Azores, and the costs of maintaining whaleships, set against the successful and economical shore whaling then being developed, discouraged the small island companies from directing their own enterprise in the direction of deep-sea whaling. Perhaps as early as 1870 (according to Faria e Silva), and certainly by the end of the century, the local Azores whaleships were all gone.

The industry in continental Portugal continued to decline throughout the latter part of the nineteenth century. Shipowners could not be persuaded to accept whaling risks: the Azores whalemen, few of whom were as yet preoccupied with the new shore industry, found ample and satisfactory employment in the long voyages of American vessels. In 1862 and 1877 the last attempts were made by the Portuguese government to persuade crews and shipowners, by special benefits, to enter the fishery. Regulations of 1886 designed to implement these laws met with little response; and deep-sea Sperm whaling everywhere was in any case a dying industry by this time. No whaleships from continental Portugal appear to have survived beyond 1900 at the latest, for they do not appear in the register of ships calling at Horta (Table 2).

The special interest of the Azores whaleman lies in the shore fishery, still surviving, established in his own islands. But in the last century there were other shore whaleries overseas where he was active, and mention of these may help to emphasize his widespread employment and substantial contribution amidst the labours and hazards of nineteenth-century whaling. There was an early colonial venture in East Africa in 1805, when Starbuck records that the Portuguese attempted to whale out of Mozambique and employed New Englanders to take charge of the business. Presumably this was a seasonal shore fishery for Humpback whales, like the steam whaling ventures which operated from Mozambique more than a century later between 1910 and 1915 (Mackintosh, 1942, p. 231). California was another country where Azoreans were active in whaling. The lagoon fishery for the Californian Grey whale

flourished for several decades and was partially conducted from shore stations. The first of these was opened at Monterey in 1851. Most of the whalemen here and elsewhere along the coast were Azores islanders who settled in California with their families (Scammon, 1874, p. 250; Clark, 1884; 1887, p. 55). There were besides Monterey at least twelve other stations, one of them called Portuguese Bend: and on all that coast the most experienced of the whaling captains was a native of the Azores. Scammon has described and figured the whaling settlement at Carmel Bay, and it must have been very similar to one of the small try-works stations like Ribeiras or Calheta do Nesquim at the present time in the Azores. Scammon says (1874, p. 250):

> Scattered around the foothills, which come to the water's edge, are the neatly whitewashed cabins of the whalers, nearly all of whom are Portuguese from the Azores or Western Islands of the Atlantic. They have their families with them, and keep a pig, sheep, goat or cow prowling around the premises.... It is a pleasant retreat from the rough voyages experienced on board the whaleships. The surrounding natural scenery is broken into majestic spars and peaks, like their own native isles....

Azores whalemen also settled in Tasmania, and served in vessels sailing from Hobart Town (Philp, 1936, p. 75). They were undoubtedly among the crews of whaleries established for Right whaling in the bays of Cook Strait, New Zealand, after 1830 (p. 338).

It seems true to say that wherever whaling was prosecuted in the last century, from ship or from shore, men from the Azores might be found among the company.

Shore whaling from 1832

Although whaling proper in the Azores started as a pelagic industry operated by the New Englanders, it appears, from Lima's account (1940, p. 391) of D. Antão de Almada's letter of 1768, that the islanders occasionally caught whales in earlier times. This primitive shore whaling may have been learned originally from the Basques who are likely to have called at the Azores when they pioneered the whaling voyage with early visits to Newfoundland. Gallup (1930, p. 271) mentions a tradition 'that Columbus, while lying at the Azores, was told of lands which lay beyond the setting sun by the captain of a whaler from "Ande Luz"'; and it may be significant that the word *vigias*, used for the old watch-towers built by the Basque whalemen many centuries ago, is used also for the present Azores look-outs, and that the word *Cachalote*, used by the Azoreans as a specific, discriminative term for the Sperm whale, is of Basque origin according to Jenkins (1948, p. 72).

The present shore fishery came long after the arrival of the New England whaleships. It seems to have started in Fayal. This is to be expected since Horta was always the premier port of call for whaleships on the Western Islands ground. But the date of commencement is uncertain. No early records survive, but Senhor Medeiros, who gave a deal of time to enquiries on my behalf, tells me that in whaling families 1832 is a date often mentioned for the first launching from a Fayal beach. The oral tradition continues that the venture of 1832 was abandoned after a time and was not resumed again until 1851, when the old try-works at Porto Pim, Horta, was improved and extended as a Sperm whale factory. This try-works, which still survives although disused, was first built in 1836. The temporary abandonment before 1851 would explain why Bullar & Bullar, in their delightful account written in 1841 of a year spent in the Azores, do not mention whaling except to say that American whalers called at Fayal for provisions. The start in 1832 may have been made by islanders, but more probably by enterprising Americans who had settled in Fayal and who, with their own tradition of New England shore whaling, would quickly have seen the advantages of the high cliffs in exploiting, direct from the shore, the fishery which for decades had attracted each year the whaleships of their countrymen. There were undoubtedly such settlers, including the wealthy and influential family of Dabney which provided United States consuls to Fayal at least from 1839 to the end of the century (Olmsted, 1841;

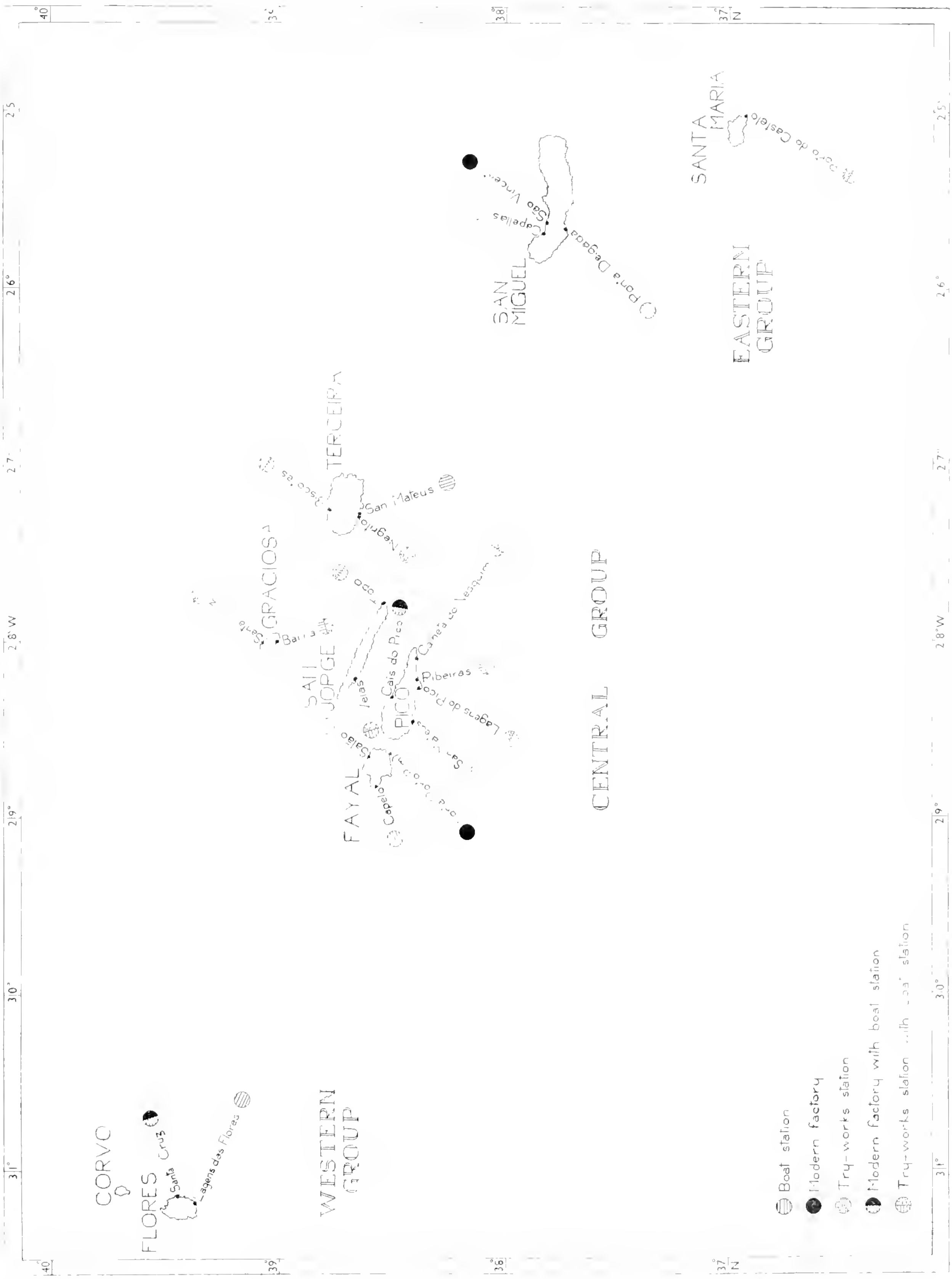

Fig. 3. Open boat whaling for Sperm whales in the Azores or Western Islands. Distribution of stations in 1949.

Monaco, 1888; Pouchet & Beauregard, 1889, p. 6). According to Lima (1940) the shore whaling business did not begin until the 1850's when Dabney and a Portuguese, Bensaude, acquired whaleboats, and Dabney set up the try-works at Porto Pim. This must refer to the date 1851 mentioned in the oral tradition. Other historians beside Lima place the start of shore whaling some twenty years later than 1832. According to Faria e Silva (1890) it began in 1856, and Chaves (1924*a*) notes that there were shore stations in Fayal and Pico a few years earlier than 1861. But where the earliest records are lost we should not dismiss hearsay evidence, and I conclude that shore whaling was started in Fayal, possibly by Dabney, about 1832, but it did not prosper and was relinquished until its revival and firm establishment by Bensaude and Dabney during the 1850's. How long it remained partially in American hands is not clear. In 1920 the Foreign Office Handbook (p. 30) declared that, 'Whaleries are conducted by the Americans: the chief are in Fayal and at Capellas in San Miguel'. However, when I visited the islands in 1949 the controlling interests everywhere were held by Portuguese, either locally or from the mainland of Portugal, and there were no Americans engaged in the industry. I believe that Portuguese have owned it entirely for a very long time.

Little evidence survives to indicate the spread of shore whaling to other islands of the archipelago, and the incidental references of travellers came mostly towards the close of the nineteenth century. From inquiries in Pico, Senhor Medeiros has learned that the business was certainly carried on there in 1880, when Anselmo da Silviera began whaling out of Calheta do Nesquim with two whaleboats brought from New England. One of those engaged in Calheta at that time, a harponeer called Raimundo, was famous for his skill, being known in New Bedford as the 'Whale-Killer'. Chaves (1924*a*) put the date in Pico earlier than 1861, and we may assume that the successful venture in Fayal in the 1850's was not long in crossing the narrow strait to Pico. Pouchet, visiting the Azores in the Prince of Monaco's yacht *Hirondelle* in 1887, made anatomical observations on a Sperm whale at Lagens do Pico (Pouchet & Beauregard, 1889). Judging from Pouchet's description and photographs, I found this centre of the old try-works companies scarcely changed when I visited the settlement sixty years later. It is an interesting fact that the old whaleships (although they recruited Pico men) seldom called at Pico, which lacked not only harbours but also provision of fresh victuals, for little grows there, except *faya** (which is used for firewood) and the vine. Yet from Fig. 4 (p. 302), showing the annual catches of the several islands between 1896 and 1949, it is clear that by the end of the century Pico had secured the lead in shore whaling. From the size of the catch and from the number of stations operating (Table 4, p. 306) there is no doubt that Pico has ever since consistently maintained this position, although the figures for the catch of whales per whaleboat at the foot of Table 10 indicate that more whales are to be found to the south-eastward, around San Miguel and Santa Maria.

The special attention that Pico has paid to whaling may well be associated with the failure of the vineyards, which were devastated by phylloxera in 1853 and have only in recent years begun to recover. Before 1853 Pico had exported wine, principally to Russia and the West Indies, where 'Pico Madeira' had acquired some fame. When this business collapsed the Pico inhabitants must have turned to the new alongshore venture as an alternative livelihood. They had such success or were so well suited to the employment that, extending ambition beyond their own coastline, they persuaded other islands to make concessions so that Pico boats and crews might whale from these also. By 1908 Pico had two whaleboats in Terceira and four in Graciosa (*Estatistica das Pescas*): when I visited the whaleboat stations of Capelo and Salão in Fayal during 1949 there were altogether nineteen whaleboats and ten motor-launches operating, but of these Pico maintained seven whaleboats and four motor-launches and the complete crews to work them (Table 8, p. 326). The island has long been known for the number of its whaling companies, all separate and competing with each other, and sometimes in

* See p. 348.

bitter and dangerous rivalry (p. 334). Recently there has been a trend towards amalgamation, as when three companies merged as Cais do Pico in 1946 to build a modern station, but even in 1949 Pico stood out from other islands in having an average of three times as many companies as there were settlements or stations (Table 4). Whaling, and the associated crafts of the boat-builder, blacksmith and cooper, are among the major occupations of the Pico islanders today. Confined by their sheer mountain to struggle for their livelihood upon its lower slopes and upon the coastal strip, the strong Pico men have long been used to simplicity and hardihood, qualities which have helped them to their special reputation among the Azoreans for unflagging effort and resolute daring in the whaleboats. With them above all the whaling tradition of the Azores is secure.

Flores, Terceira and San Miguel (Fig. 3), the islands other than Fayal frequented in the nineteenth century by whaleships, probably followed after no great lapse of time the shore whaling venture of Fayal in the 1850's. But I cannot find any details. A likely time for the start of shore whaling from San Miguel was the period during the 1870's when Ponta Delgada temporarily competed with Horta as the entrepot for the American whale oil and provision trade. The whalery was set up at Capellas on the north coast, and it is still the principal whaleboat station although the try-works are now disused. The station was evidently in existence some years before 1890 when Pouchet and Chaves examined a Sperm whale taken from San Miguel. Whaling flourished in the island, for a comparatively larger number of whales frequents this locality than the seas of the Central and Western groups. Like Fayal, although not to the same extent as Pico, the island has maintained whaling on some sort of scale no matter how small, even during the several periods of acute depression which have made whaling everywhere in the world since the 1870's and 1880's an industry of extraordinarily fluctuating fortunes. Whaling in Terceira, with a whaleboat station at San Mateus and try-works at Negrito hard by, started earlier than 1895, when the Prince of Monaco's yacht *Princess Alice* witnessed the killing of a Sperm whale by Terceiran boats (Buchanan, 1896; Monaco, 1896; Richard, 1907). There was another station on the north coast at Biscoites, but the whale fishery in Terceira does not seem to have prospered in this century, and was for a long time defunct until revived when the last war began (Fig. 4). To the westward, Flores, supplying recruits as well as fresh provisions to the deep-sea whaling, has had an association with the whaleships as old as that of Fayal, although not so important. In 1862 many boatloads of whalemen landed in Flores: they were survivors of the tragedy of civil war and the wholesale burning of Yankee whaleships by the Confederate cruiser *Alabama* (Semmes, 1869, p. 445). These men were shipped back to the Federal States and it is very probable that they sold their whaleboats locally before departure. I wonder if these boats were used to start the whaleries at Santa Cruz and Lagens das Flores. We know from the statistics given by Faria e Silva (1890) that there was certainly whaling from Flores by 1886, but it seems to have fared little better in Terceira for the first three decades of this century.

In the remaining four islands of the archipelago there have been whaleries at least since the late nineteenth century, but they have been conducted (until the beginning of the last war) more or less intermittently and on quite a small scale. This is apparent from the island catch graphs in Fig. 4. Corvo was whaling at least as early as 1886. Smallest and most remote of the Azores and lying 12 miles north of Flores, this island maintained between six and eleven whaleboats in the decade following 1895, yet only one whale was caught during that time (Table 10), and subsequently whaling from the single landing place at Rosario has been abandoned. The small and poor community could not afford to maintain such an unproductive fishery. No doubt the Corvo whalemen were defeated, not by a shortage of whales, but by the surf, which, beating everywhere about this unsheltered island, must have made their peremptory embarkations often perilous and sometimes impossible, and have equally endangered the subsequent beaching of the whaleboats and the proper stranding and cutting in of the

captures. Nevertheless, Corvo still plays its part in whaling, for I have been told by Colonel Agostinho that towards the end of July a look-out is manned on the Corvo cliffs and some whaleboats belonging to Flores are brought across the strait to fish from Rosario, although the dead whales are towed back to Flores for working up. In this way the look-outs command the northern ocean prospect otherwise obscured from Flores by the loom of Corvo. Turning to Graciosa and San Jorge in the Central Group, we know from the official statistics (Table 10) that whaleries had been established in these islands by 1896. Probably they started a good deal earlier. Graciosa has made little headway, but San Jorge, although whaling with occasional intermissions, appears since the turn of the century to have been as active as Fayal except that it has not shared so obviously in the period of expansion after 1940. To the south-eastward Santa Maria, the remaining island to be considered, was whaling in 1896, although within ten years the industry had lapsed despite the comparative abundance of whales round the Santa Maria coasts (p. 298). Possibly the island experienced difficulties akin to those of Corvo. No island in the archipelago is more steeply cliffed or more beset with dangerous reefs than Santa Maria. But in 1937 the whalery was revived. I do not know whether the single station at Porto do Castelo (p. 341) is the original one constructed some time in the nineteenth century, but it has secured, during the twelve years to 1949, a higher average catch per whaleboat than that of any other island (Table 10).

Since 1900 the Azores whaling industry has undergone developments or has acquired certain modern adjuncts which, although they have left intact the essential traditions and methods of open boat whaling, have greatly improved the efficiency possible 100 years ago. Surveying these, and the recent history of the fishery, it is useful to refer, not only to Table 1 and Fig. 2, comparing the Azores and the world catches, but also to the catch of whales per whaleboat for the archipelago, shown in the extreme right-hand column of Table 10.

A preliminary step taken by the island whalemen was to make themselves independent of New England for the boats and special equipment of the whaling business. During the nineteenth century all the whaleboats were imported from New Bedford. But in 1894 a whaleman and shipwright of Lagens do Pico, called Francisco José Machado (as I am informed by Senhor Medeiros) built the first local boat: the other islands, following the Pico lead, drew upon their indigenous tradition of small boat construction, and by 1900 all the necessary whaleboats were built locally. At the present time the whaleries are largely self-sufficient, and save for the special cooking equipment of modern factories, they import only ropes, try-pots and motor-boat engines. All the other gear, the harpoons, lances and cutting spades, the coopered barrels and tubs, the boat furnishings and the motor-boat hulls, are made in the islands.

The most important step forward has no doubt been the introduction of motor tow-boats. Even these had an American precedent in nineteenth-century whaling, for a 28-ft. steam launch was successfully operated from the bark *Rainbow* as a tow-boat for whaleboats and captured whales in the North Pacific Bowhead season of 1882 (Brown, 1887, p. 246). Senhor Medeiros has established that a motor-boat for towing purposes was first used by the Fayal whalemen in 1909. The effect of this development was not immediately apparent, for the industry suffered a period of depression during the four years between 1911 and the beginning of the First World War. Sperm oil during the 1900's was exported to London and to the United States (*Estatistica das Pescas*), but it had at this time few uses except as a lubricant and as a fuel sufficiently superior to kerosene to be required for railway signal lamps and for lighthouses: spermaceti, which had formerly provided the finest wax candles, found only limited employment in making cosmetics and medicinal salves, and in reinforcing the cheap paraffin candles which had ousted it. Up to 1910 the modest demand arising from these uses could be met without superfluity by the production from the Azores, and in a lesser degree from other

land stations and from the few surviving whaleships. The first decade of this century was in fact a reasonably profitable time for the shore whaleries, and the capital outlay on motor-boats must have reflected this comfortable phase. But for a few years after 1910 the small market became glutted with oil derived from the occasional attention paid to Sperm whales by the steam whaling industry, still active in the north and already established and expanding in the new southern whaling centres of the Sub-Antarctic and Antarctic. In consequence the Azores companies were faced with difficulties in selling their oil and the catches declined. Table 1 shows that the archipelago accounted for 72·3 per cent of the world catch of Sperm whales in 1910 but only 3·8 per cent by 1915. But the reduction of Allied whaling in the midst of the 1914–18 war (Fig. 2), combined with the increased war-time demand for sperm oil, brought renewed prosperity to the Azores. Motor tow-boats, of which Fayal had eight by 1918, were generally employed among the islands, and these must have combined with the increased catching effort to produce the noticeable war-time increase in the Azores catch of whales per whaleboat.

The motor-boats have obvious advantages. When a blow has been raised from the cliffs a motor tow-boat can rapidly take two or three whaleboats to the neighbourhood of the whale, whereas formerly a stiff on-shore breeze might mean precious time occupied in miles of tacking, which could lose them the whale before they were close enough for a dart. In this sense the effective range of the whaleboats has become substantially extended. The close approach necessary for hand harpooning means that the noise of an engine would frighten the quarry, so that motor tow-boats are never used for the actual securing of whales, but during the hunt they are invaluable for giving short tows to the questing whaleboats, for bringing up spare whaleline in emergency, for assisting damaged boats, and for prolonging the hours of chase available to whaleboats which would otherwise be benighted. Finally the motor-boats tow the dead whales back to the whaling station, a distance perhaps of twenty or more miles: this was formerly a weary back-breaking task for whaleboats under oars, pulling with the likelihood of being benighted off a hard coast, and with the possibility of worsening weather and subsequent loss of a hard-won prize.

It is an arresting contrast of the period 1920–30 that in these years, when the general employment of motor tow-boats gave the old-fashioned whaleries their first aspect of modernity, the Azores whalemen finally abandoned the occasional employment of firearms in fastening and killing whales and used exclusively the trusted and primitive weapons of the whaling trade, the hand harpoon and lance. As early as 1731 Britain was the first nation to introduce harpoon-guns into whaling; these were unsuccessful, but there were swivel-guns employed satisfactorily in British whaleboats at the Northern Right whale fishery after 1772 (Scoresby, 1820, II, p. 70), although they never became popular until the 1850's. Such pieces of ordnance were practicable in this fishery, whaling in ice bays of the summer Greenland Sea, but when the New England whalemen in 1846 first turned their attention to firearms, they developed not swivel-guns but small-arms, which were handier and more accurate in the open weather of ocean Sperm whaling. By the 1870's each American boat usually carried a shoulder-gun, a supply of bomb-lances, and a darting-gun in addition to the hand weapons. The shoulder-gun fired a small lance fitted with a bomb, and was used to kill a whale which had previously been fastened with the hand harpoon. The darting-gun was a hand harpoon ingeniously combined with a stockless gun-barrel which automatically discharged a bomb-lance as soon as the harpoon iron fastened. Bomb-lances were so useful in securing a quick kill and in mitigating the perils of whaling that by 1874 the hand harpoon was rapidly going out of practice in American whaleboats and in 1887 was kept only for emergencies (Scammon, 1874, p. 228; Brown, 1887, p. 252). The Azores shore whaling business took over firearms with the rest of American gear and methods. In the *Estatistica das Pescas* there are lists of catching equipment where *carabinas* and *espingardas* are

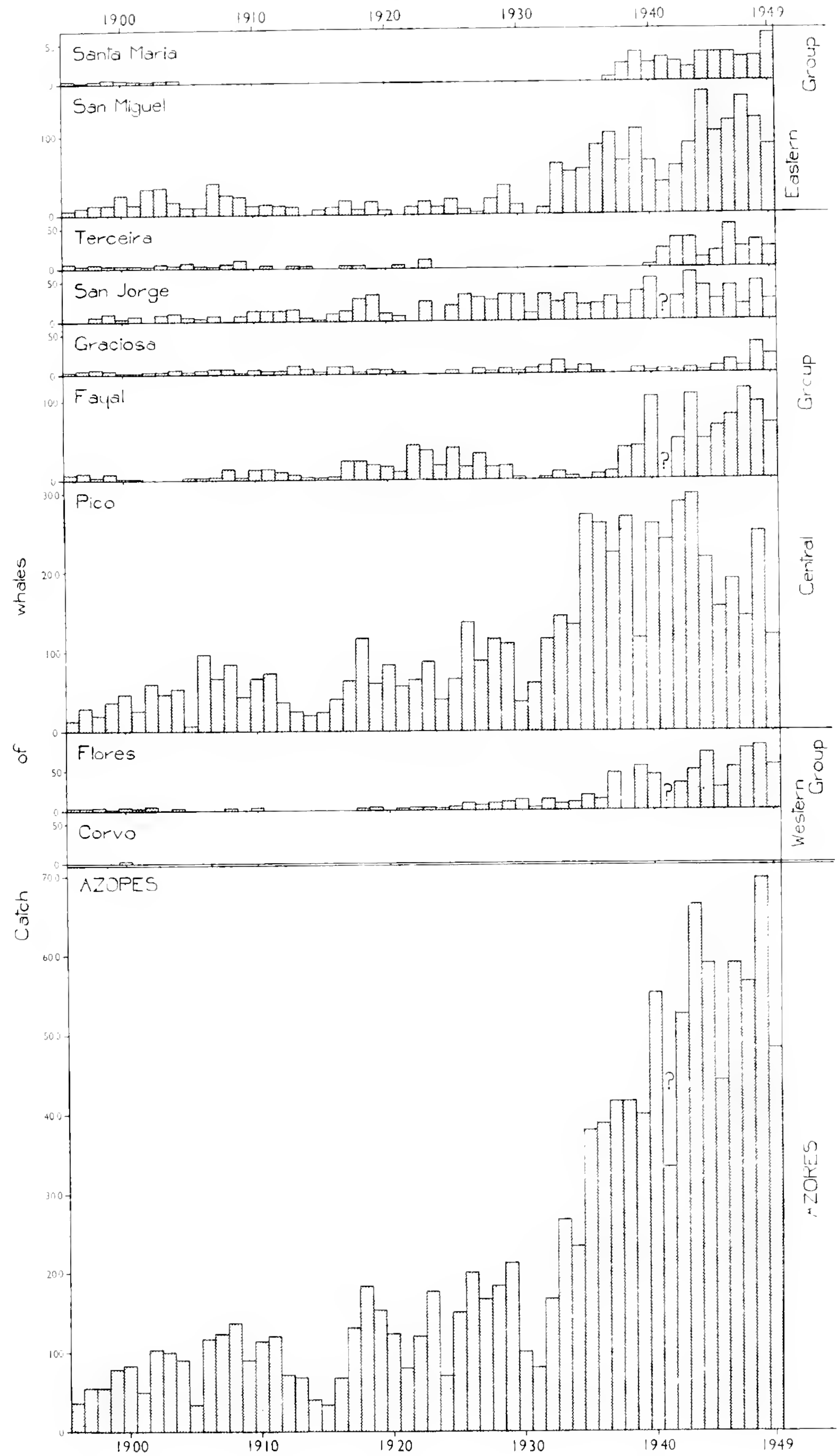

Fig. 4. Sperm whales. Annual catches in the Azores from 1896 to 1949.

mentioned, although intermittently and in decreasing numbers, for several whaling stations between 1905 and 1926. *Bomblanços* are listed for 1929, and I believe that *carabinas* ('carbines') were shoulder-guns and *espingardas* ('muskets') were darting-guns, but I cannot prove this because the American terms have no Portuguese equivalents. Compared with the listed numbers of hand weapons, few of these guns were in use at any time, and it is unlikely that they were ever popular with the islanders, if only because of the relative expense involved. In San Miguel there were still two *espingardas* available in 1934, but these seem to have been the last. Firearms are never used at the present time anywhere in the Azores. An experimental hand lance with an explosive head, electrically detonated, has been tried in Fayal, but not adopted (Figueiredo, 1946, p. 104). The weapons of Azores whalemen today are patterns of hand harpoons and lances which existed a century ago. Why small-arms have been completely relinquished is not very clear. A similar shift to the old hand weapons took place in the last years of the whaleships when these also were manned largely by Portuguese. Ashley attempted to explain this by the need for economy, or by the possibility that Portuguese whalemen had less assurance with explosives than the Americans (1926, p. 88). Firearms certainly had one disadvantage in Sperm whaling: they were best reserved for lone bulls because schools were frightened and dispersed by the detonations; and it is a fact that most whales round the Azores are in schools.

In the 1920's an important event for Azores whaling was the formation of the Grémio dos Armadores da Pesca da Baleia, an official organization with offices in Lisbon. This Association of Whaling Owners has something of the attributes of a medieval guild. All whaling owners or companies are members of the Grémio and it includes representatives from the Ministries of Marine and of Economics. Its functions are to safeguard the welfare of the whaling industry, promote its development and increase its efficiency; to arrange the most advantageous terms for the sale of sperm oil and whale products in foreign markets; to make rules for the conduct of the fishery and for the rightful ownership of disputed whales; to regulate the equipment and manning of the whaleboats and motor tow-boats and regulate the conditions of recruitment, organization and pay of the whalemen; to collect statistics and records, and make regulations for conserving the whale stocks; and for all these rulings to establish against their non-observance penalties of money fines or the withdrawal of whaling licences. The rules and regulations of the Grémio were published in 1925 and a revision of the constitution and administration was issued in 1945 (Grémio dos Armadores da Pesca da Baleia, 1925, 1945).

The Azores catches fluctuated considerably in the 1920's although the general trend was a rising one. London and Lisbon received most of the oil, and little was exported direct to the U.S.A. The general slump of 1930–31 is clearly seen both in the world and in the Azores catches (Figs. 2 and 4). But by 1930 new uses were beginning to be found for sperm oil and spermaceti in the chemical and textile industries. Research and development in this field were particularly active in Germany, and it is significant that between 1930 and the outbreak of the Second World War the oil produced by the Azores found a market in Hamburg as well as in London and Lisbon. The catch figures for the world (representing largely Antarctic catches) and for the Azores, and the increased effort shown by the Azores catch of whales per whaleboat (Table 10) together boldly reflect this renewed interest of industrial markets in sperm oil during the 1930's. Today new uses continue to be found for the oil. Its chemical composition is very different from that of oil from Whalebone whales, which consists of true fats capable of being hardened into edible oils. Sperm oil is largely a mixture of waxes. It does not provide edible oils, but its present applications cover a wide field including cosmetics, soap, liniments and medicines, machine oils, plasticizers and fillers, paints and varnishes, roofing board, and the hardening of metals. A good deal goes to make sulphonates for the textile industry (*Norsk Hvalfangsttid.* 1948, p. 456), and for the new sulphonated detergents.

In the Azores the increasing prosperity after 1931 was accompanied by the introduction into one

island of modern methods of treating the carcass. Even today most of the whaleries of the archipelago cut in their captures either stranded on the beach or laid alongside a jetty. The ancient usages of the cutting-spade, assisted by rope-tackles and a hand capstan, are employed to remove the spermaceti organ and the blubber which are afterwards melted in iron try-pots (pp. 334 ff.). The stripped carcass with its valuable meat and bone is not used, being simply towed out to sea and dumped. During the depressed period of 1924 (Fig. 4) Chaves had called for modern processing which would save wastage and would produce a superior oil and make by-products in addition (1924*a*). But the necessary capital outlay had to wait for better times and it was ten years later in 1934 that the Azores acquired their first modern factory employing steam power for heaving-up the whale, for flensing winches and for pressure-cookers. The station is on San Miguel at São Vincent, a mile or so east from the try-works at Capellas which it replaced.

No further stations were built until the Second World War. Whaling in the Azores at this time, for reasons similar to those operating in the First World War, entered its period of greatest prosperity. Towards the end of the war, in 1944, when allied steam whaling was practically at a standstill although the market for sperm oil was unlimited, the archipelago contributed 40·3 per cent of the world catch of Sperm whales. Stimulus and capital were alike present for ventures with further modern stations. The factory at Porto Pim, Horta, was built in 1943 and two others followed, one at Cais do Pico in 1946 and one at Santa Cruz das Flores about the same time. The latest new station, at Lagens do Pico, which was built as far as its foundations in 1949 and was then temporarily abandoned because of a poor oil market, is now nearly completed and should start operations this year or in 1954. All the four modern stations now operating extract the blubber, spermaceti, and bone, and three of these stations also process the meat for meat-meal. At least one station installed a liver-oil plant in 1951. Methods of working up whales at these modern stations have been developed independently from those at whaling factories overseas (pp. 342 ff.).

Mention of one other technical adjunct brings the Azores whaling scene into its present state of development. Radio-telephone communication between look-outs and motor tow-boats was introduced during the war. The advantages are obvious enough, especially in giving revised bearings of sighted whales to the launches at sea, and also in permitting centralized control and organization of whaling sallies round all the coasts of an island. I believe San Miguel was the first island to take up radio-telephony for whaling, and it is there that the innovation has been most developed. In 1949 all the modern factories employed radio-telephones in their motor-boats and look-outs but certain of the islands which only possessed try-works had not then installed the equipment. The look-out at Santa Maria had a radio-telephone but nobody to operate it. This is symptomatic of the entry of a new technician class into the ancient practice of open boat whaling, for the industry which at the try-works whaleries still employs (saving a motor-man for the launches) simply boatmen and boat-builders, blacksmiths and coopers, requires at the modern stations engineers, mechanics and wireless operators.

Since the war ended the fortunes of Sperm whaling in the Azores have continued to fluctuate. The islands were much affected by the great post-war catches of Sperm whales in the Antarctic and off Peru (Fig. 2), and in 1949 much difficulty was experienced in selling the Azores production. Recovery in 1950 and 1951 was associated with the outbreak of war in Korea: times of war and rearmament seem to be boom periods for sperm oil. In the present year (1953) the Azores share the world recession in whaling due to a temporary glut of whale and sperm oil. This need not be expected to last.

The future may expect to see the numerous try-works stations eventually superseded everywhere by modern methods of oil production, for since Chaves's time the need for these technical developments, including the manufacture of by-products, has been stressed by other Portuguese authors (Figueiredo, 1946, 1951; Carvalho & Carvalho, 1951).

Table 4 summarizes the condition, in stations and material, of Azores Sperm whaling at the time of my survey in 1949. The eight islands with whaleries maintain in all twenty-one stations and, discounting the new installation at Lagens do Pico which is not yet operating, only four of them include modern factories. The others number eleven try-works stations (all but one with whaleboats operating directly from them), and six stations for whaleboats only. It is the object of the next section to describe in detail the equipment and the methods of hunting and of processing whales in this open boat fishery as it survives today.

THE PRESENT SURVIVAL OF OPEN BOAT WHALING

The open boat whaling of the Azores is a relic industry which, surprisingly enough, has spread rather than dwindled in the North Atlantic in recent years. That it should have spread from the Azores to Madeira in 1941 (p. 350), and that on the coast of Brazil open boats should have begun to take whales in 1950 (*Norsk Hvalfangsttid.* 1952, p. 499), are healthy signs in the survival of the ancient trade. There are no details available of the tiny revival in Brazil, but the whalemen concerned are almost certainly immigrants from the Azores (p. 295).

Elsewhere in the world the practice of open boat whaling is outmoded and obsolete. The last deep-sea voyages in the old style were completed when the schooners *Margarett* and *John R. Manta* returned to New Bedford in 1925. The shore fishery on the eastern seaboard of North America, where as early as 1645 the settlers of Southampton, Long Island, had regulations for whaling, came to an appropriate end in 1918 when a Right whale was harpooned at Amagansett, Long Island (Starbuck, 1878; Edwards & Rattray, 1932). At Twofold Bay, West Australia, once a famous centre for bay whaling, there lingered a seasonal open boat Humpback fishery until 1932 when, according to Dakin (1934), the two remaining whaleboats ceased to operate. Old-style bay whaling in New Zealand had vanished years earlier, when in 1910 at Whangamumu, Bay of Islands, the open boat and hand harpoon were replaced by steam catchers which took over the Humpback whaling there (Ommaney, 1933). The Yankee whaleboats which once hunted on the Peru coast have since been copied by Peruvian fishermen, but it is not clear that these *boniteras* are used for whaling (*Norsk Hvalfangsttid.* 1952, p. 73). In high northern latitudes the natives still hunt Right whales from open boats when opportunity affords. But recent accounts show that hand weapons for Right whaling are obsolete, at least among the Alaskan and Canadian Esquimaux, who now use swivel-guns, shoulder-guns with bomb-lances, and darting-guns (Valin, 1945; Anderson, 1947; Brower, 1948, p. 103). In this there is no comparison with the Azores where the abandoning of explosives binds them much closer to tradition. In the northern fisheries for the White whale or Beluga, small types of hand harpoon and lance are still used for despatching the captures (Vladykov, 1944, p. 32); but this species, despite its name, is a dolphin of no great size, and the actual capturing is done with stake-nets. In certain parts of the South Seas, such as the Tonga Islands, the hand harpoon still survives, but here also the present native fishery is, I believe, only for dolphins and porpoises.

It is surprising that the survival of shore whaling in the Azores, as singular as it is outmoded, should for so long have attracted scant attention from travellers and students of whaling. Except for one reference by Jenkins (1921, p 249) there was virtually nothing written outside Portugal about the Azores fishery until Knudsen's short note (1946) when, as a member of the *Atlantide* Expedition, he had visited the whaling station at Horta, Fayal, though not at a time when whales were being hunted or worked up. Recently, a brief, popular account by R. J. Houk appeared in the *Norsk Hvalfangsttid.* (1952, p. 667). I have contributed an article to the same journal (Clarke, 1953). Shortly before my departure for the Azores in 1949 I was able to see Figueiredo's valuable monograph, mainly describing the present condition of the industry, published in Portuguese in 1946.

Table 4. *Open boat whaling in the Azores. Condition of the industry in 1949*

Island	No. of look-outs	Station	No. of companies	Description of station	Method of working up whales	No. of motor tow-boats	No. of whale-boats
Santa Maria	1	Porto do Castelo	1	Try-works station with boat station	Stranded on beach	2	4
San Miguel	8	Capellas	—	Boat station	—	3	8
		Ponta Delgada	—	Boat station	—	2	5
		São Vincent	1[2]	Modern factory	Heaved upon flensing platform		
Tereeira	6	San Mateus	—	Boat station	—	1	3
		Negrito	1[2]	Try-works station	Stranded on slipway		
		Biscoites[1]	—	Try-works station with boat station	Stranded on beach	1	3
San Jorge	5	Velas	1	Try-works station with boat station	Laid alongside jetty	2	6
		Topo[1]	1	Try-works station with boat station	? Stranded on beach or slipway, or laid alongside jetty	2	6
Graciosa	4	Barra[1]	1	Try-works station with boat station	? Stranded on beach or slipway, or laid alongside jetty	2	4
		Santa Cruz[1]	1	Try-works station with boat station	? Stranded on beach or slipway, or laid alongside jetty	2	4
Fayal	7	Capelo	—	Boat station	—	8	13
		Salão	—	Boat station	—	2	6
		Horta (Porto Pim)	1[2]	Modern factory	Heaved upon flensing platform	—	
Pico	9	Cais do Pico	1	Modern factory with boat station	Heaved upon flensing platform	5	9
		Lagens do Pico	7	Try-works station with boat station	Stranded on slipway or laid alongside jetty	5	14
		Ribeiras	3	Try-works station with boat station	Stranded on beach or laid alongside jetty	3	9
		Calheta do Nesquim	2	Try-works station with boat station	Stranded on beach or laid alongside jetty	3	8
		San Mateus	1	Try-works station with boat station	Stranded on slipway or laid alongside jetty	2	4
Flores	7	Santa Cruz	1	Modern factory with boat station	Heaved upon flensing platform	4	8
		Lagens das Flores[1]	? 2	Boat station		4	8
Corvo	—	—	—	—	—		—
Azores	47	21	25	Boat stations 6 Modern factories 2 Try-works stations 1 Modern factories with boat stations 2 Try-works stations with boat stations 10	Stranded on beach or slipway 3 Laid alongside jetty 1 Stranded on beach or slipway, or laid alongside jetty 4+? 3 Heaved upon flensing platform 4	53	122[3]

[1] Stations *not* visited during the survey.
[2] In islands where there is a single company operating more than one station, the entry is made opposite the principal station.
[3] The census of whaleboats was from personal inquiry: the official figure for 1949 was 125 (Table 2).

The following account is not intended to duplicate Figueiredo's descriptions. It rather attempts a comparative approach which may examine and establish the degree to which the traditions of old-style American Sperm whaling have been retained in the existing gear and methods of the Azores industry.

For comparisons with the American gear and methods I have found two long papers by J. T. Brown, in 1884 and 1887, to give the best account of the construction and furnishing of nineteenth-century whaleboats and of all those products of blacksmith work, the harpoons, lances, spades, and trying out implements, which were collectively known as 'craft' or 'whalecraft'. Illustrations of whaleboats, boat-gear and craft are shown best in the Atlas of plates in Goode, G. B. & Associates (1887), and also in Starbuck (1878, pl. III–VI), and in Scammon (1874, ch. III) whose text is also comprehensive, but not so detailed as that of Brown. To compare the hunting of whales then and now, there is much precise information in Melville's book (1851). There are other good first-hand accounts of whale hunting in J. R. Browne (1846), Cheever (1851), Nordhoff (1941, posthumous), Haley (1950, posthumous), Davis (1874), Bullen (1901), although the latter has some inaccuracies of nomenclature, and Ashley (1926), Murphy (1947) and Chippendale (1953), the last three authors having sailed in the late nineties or early years of this century near the end of the whaleship era. All of these, but principally Melville, Browne and Davis, also give details of cutting in and trying out. The narratives cover some seventy years of Sperm whaling, but the advances over that period (in part reviewed by Ashley, 1926) only concerned details, like the advance from fixed-flue to toggle harpoon, the use of small-arms, and the introduction of centre-boards in whaleboats and a second tub of line. Otherwise these descriptions do not contradict each other, so I have mentioned the authors here in order to save overburdening with references the comparative passages in this description of the Azores open boat whaling as it was in 1949 and remains today.

The cliff look-outs

Except for Santa Maria each island has several look-outs or *vigias* placed at intervals on the cliff tops (Table 4). In Santa Maria there is only one look-out, located in the south-east corner of the island. There is a look-out above every station where whaleboats are kept, and the remaining look-outs in an island are spaced so that together all command as much as possible of the ocean prospect. The arc of search is methodically swept with binoculars, and each arc substantially overlaps that of the adjacent look-out on either hand: in this way a large area of sea from two or three miles off-shore outwards to the horizon is searched for the blow of Sperm whales by two or more look-outs simultaneously. This is illustrated in Fig. 5, giving the dispositions and arcs of search of the Fayal look-outs whose names and organization are set out in Table 5. For the details in this table I am indebted to Senhor Tomas Alberto de Azevedo who took a special interest in showing me the look-outs of Fayal.

All look-outs seem to be permanent structures. Those recently built or rebuilt are made of stone faced with concrete. Such a recent example which I visited is the look-out in the cliff some 700 ft. above the try-works station at Porto do Castelo, Santa Maria. It is about 14 ft. square, and the seaward wall extends upwards only half-way to the eaves so that the watchers have an unrestricted view. At the end of the day's search this window can be closed by a wooden shutter which in the hours of manning is propped up like a shop sun-blind (Plate XIV). Fayal has some similar light and airy structures, but there is an old *vigia* in use at Atafona above the whaleboat station of Salão on the north coast of Fayal. This look-out is a weathered barn, with freestone walls of larva rock, standing beside a field of maize sloping to the cliff edge. I found it a dark, raftered place inside, mostly filled with trusses of hay, except for one corner where a solitary watcher bestrode a rough stool in front of a small unglazed window. A singular look-out is to be found at Monte da Guia, a ruined volcano which

towers above the modern factory at Porto Pim. Near the summit of this bold eminence, commanding the southern prospect at a height of 400 ft., there is isolated the little church of the Senhora de Monte da Guia, patron saint of the whalemen. The *vigia* is the vestry of this church.

Table 5. *Open boat whaling in Fayal. Look-outs and their organization in* 1949

Locality	Reference to Fig. 5	Look-out	Manning	Binoculars	Signals
Horta	1	Monte da Guia	1	16 × 40	Rocket and white flag
Castelo Branco	2	Mòrro	2	20 × 50, 2 *pairs*	Rocket and white flag
Capelinhas	3	Costado Danau	3	30 × 40 20 × 50, 2 *pairs*	Rocket and white flag *and R T*
	4	Alto das Concheiras	1	24 × 60	Rocket and white flag
Cedros	5	Cabeço Vigia	2	20 × 50, 2 *pairs*	Rocket and white flag *and R T*
	6	Cabeço Capitão	1	18 × 50	Rocket and white flag
Salão	7	Atafona	1	16 × 40	Rocket and white flag

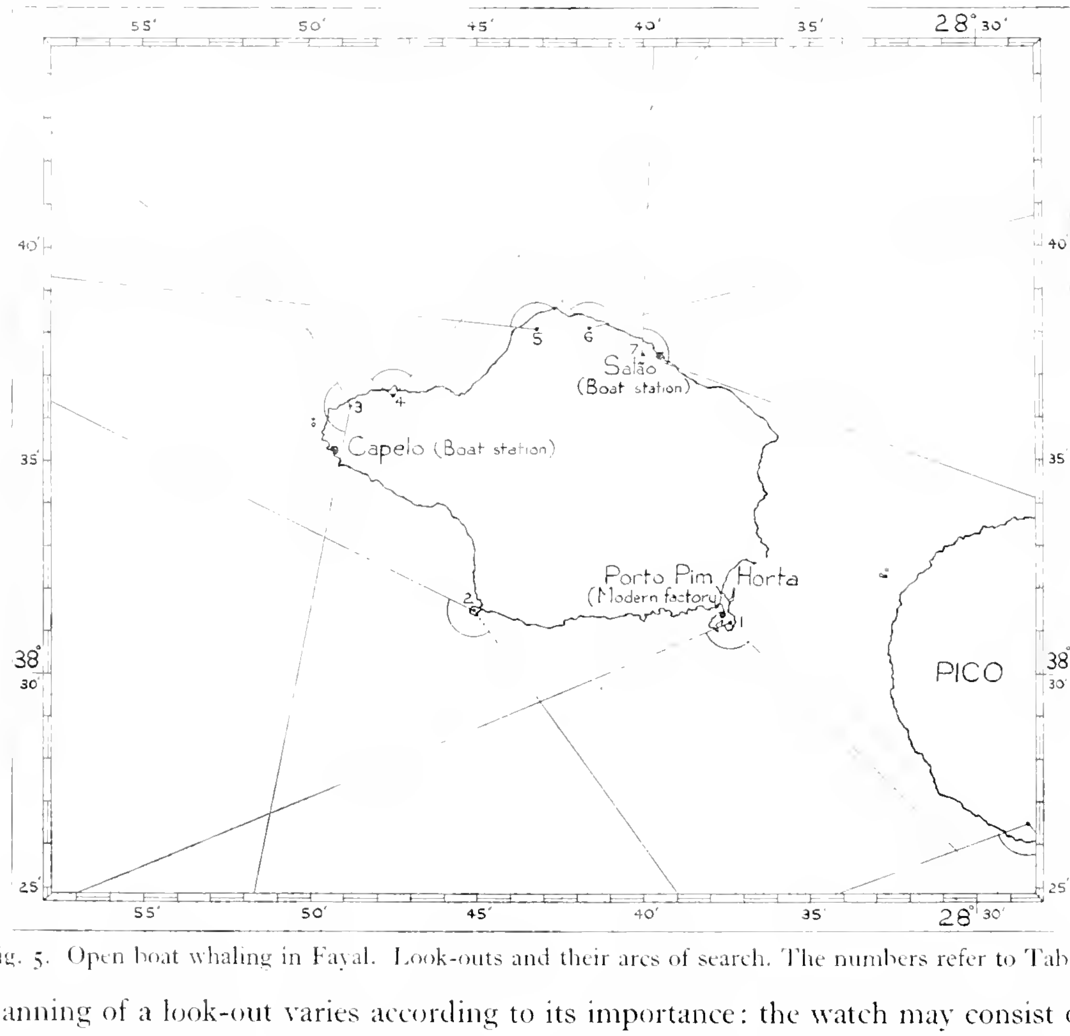

Fig. 5. Open boat whaling in Fayal. Look-outs and their arcs of search. The numbers refer to Table 5.

The manning of a look-out varies according to its importance: the watch may consist of one, two or three men, and the look-outs are manned all the year around from dawn to four or five o'clock in the afternoon. If a blow were raised at some later hour the whalemen could not in general expect to kill before nightfall. With good visibility and little wind, the likeliest time for raising a whale is that period of low level light between dawn and sunrise: the whaling returns show that a good number of whales are sighted around six in the morning. Powerful binoculars are employed, some of them with magnifications up to thirty diameters. According to Senhor Tomas Alberto de Azevedo it is possible

in the best of weather conditions for an experienced watchman to glimpse from the high vantage of these cliffs a blow at 30 or 35 miles distance. The blow of a Sperm whale is low and bushy compared with that of a Blue or Fin whale, but it does not appear to disperse more quickly and it has the advantage to whalemen of being many times repeated after a sounding. In the look-outs the binoculars are lashed to a square of wood which can be tilted on a thumb-screw pivot, and is rotated through the arc of search upon a vertical wooden pillar fixed between the watcher's knees (Plate XIV). A compass is fixed to this arrangement so that a bearing can be obtained.

When a blow is raised, or a number of blows from a school, the subsequent procedure varies according to the number of look-outs on the island, how far they are controlled by the same companies, and the extent to which radio-telephone communication is organized. All look-outs fire a rocket to warn the whalemen to launch their boats forthwith and take tows from the motor-boats in readiness. All look-outs run up a white flag on the flagstaff invariably associated with a look-out. In this they preserve the former practice of their compatriots in Californian shore whaling when a flag was likewise hoisted as a signal. In the Azores the flag is not intended for signalling to the whaleboats. Where there are several look-outs on a coastline and none or only one or two have radio-telephones, the flag is used for informing adjacent positions: this warning is essential where whales have been sighted from a look-out which has no nearby whaleboat station. It is also a signal to the whalemen's families which may dwell inland from the coast. When a kill is made the white flag is half-masted, so that a try-works can be prepared and food for the returning whalemen got ready. For signalling the bearing of sighted whales from cliff to motor tow-boats without radio-telephone, two white sheets are spread upon the cliff and the boats keep these sheets in line as they make out from the coast. As soon as the watchers feel that the motor-boats have approached as near as they dare without frightening the whales, that is, when about a mile from their quarry, the sheets on the cliff are removed and at this signal the motor-boats cast off their tows, and the chase proper begins from whaleboats under oars or sails according to the ancient method. Signalling with sheets is of course superseded in look-outs employing radio-telephone communication. These can transmit revised bearings to the motor tow-boats as often as may be necessary. Other look-outs are warned by radio-telephone, and reports are also relayed to the head-quarters of the whalery, or some other convenient place, for the information of whaling owners and factory personnel. The apparatus receiving messages from the Fayal look-outs is installed in a room above a shop near the old Spanish water-gate at Porto Pim, Horta: it is called the *casa dos baleieros*, the whalers' shop, where the whalemen have credit and get most of their domestic supplies. In San Miguel the headquarters station is located on the top floor of Senhor Pedro Cimbron's offices in Ponta Delgada, and is organized as a planning, operational and strategic centre in regular and frequent communication with look-outs and motor tow-boats; here the supervision exercised can be compared with that of the expedition manager aboard a modern floating factory in southern whaling.

The whaleboat: its gear and employment

The only outstanding difference between the present Azores whaleboat and the boat lowered from nineteenth-century American whaleships is that the Azores craft is a seven-man boat and consequently longer than the six-man boat universally employed in the American whale fishery. Otherwise it will be seen that there are some details which actually preserve the typical mid-century boat of the heyday of Sperm whaling rather than the boat at its ultimate development in the stagnant period between the 1880's and the end of whaleship days. Increasing the length has not diminished the extraordinarily graceful lines and the superb sailing qualities of the whaleboat. Comparing the plans and photographs of earlier authors, it seems indeed that the lines of the surviving Azores boat are perhaps finer and the appearance even more beautiful. Few can now compare the old boat and the

present one as sea boats and sailers, but from what I have seen in the boats, pulling or sailing on tireless rapid manœuvres in windless heavy swells or moderate wind and sea, they can today certainly equal and perhaps challenge Ashley's justified boast that the Yankee whaleboat, as finally evolved, was 'the most perfect water craft that has ever floated'.

To impress the completeness of the Azores survival of whaleboat, gear and 'craft', Table 6 (p. 314) shows in summary form the main construction features and complete equipment of a late nineteenth-century American boat fitted for Sperm whaling compared with those of a present Azores whale boat. As earlier mentioned (p. 293), the survival of old-time whaling extends to common speech, to several Yankee whaling terms used by the Azores whalemen: therefore, elaborating on Table 3 and explaining terms and usages, I include in the following description the Azores phonetic spelling in brackets after a New England term, where a word in English of the old-style whaling remains unaltered and untranslated in the conversation of these Portuguese whalemen. Besides the photographs and stills from the cine-film (Plates XIII and XV), illustrating the survival generally, this account of whaleboat and boat-gear is helped out by photographs of a model boat and its equipment, an exact replica built by a whaleboat builder of Pico (Plate XIV).

The whaleboat. The Azores whaleboats are always called *canoas dos baleieros* or, simply, *canoas*. This name reaches back beyond the Yankee tradition and is an everyday reminder of the origin of the New England whaleboats, and even of the source and inspiration of New England whaling, for the colonists of Massachusetts, although early influenced by English and Dutch models, got some of their whaling practice from the Nattick Indians who showed them the primitive employment of the Red Indian canoe in shore whaling, and later sailed for many decades as harponeers and boatmen in the deep-sea ventures. The canoe origin is still apparent in the general aspect of the whaleboat, and particularly in the gradual tapering from the midships beam towards both ends, as compared with the independently evolved English whaleboats, which were nearly uniform in width so far as bows and quarter where they were sharply rounded in.

All the Azores boats are built locally. Fitted complete with all equipment a whaleboat in 1950 cost about 4000 escudos or £500. Most boats are 37 or 38 ft. long, but there are some of 34 or 35 ft., and I have seen a 30-ft. boat at Porto do Castelo, Santa Maria. Probably the latter carries six men only, for as late as 1937 the figures in *Estatistica das Pescas* show that the whaleboats of Santa Maria were six-man boats. But the overwhelming rule in the Azores is the long seven-man boat. There is a boat-header in charge at the tiller or steering-oar, and six men paddling or pulling. This appears to have been general practice since about the turn of the century. The first locally built boat, by Francisco José Machado in 1894, followed the standard pattern of American whaleboats of the time and was 28 ft. long with a crew of six. The present Azores boats are not without precedent, either for crew number or length, in open boat whaling since the boats of the English Greenland fishery, although only 26 or 28 ft. long, commonly employed seven men (Scoresby, 1820, II, p. 222), and on two occasions only the Americans built experimental boats, for towing and for Sulphur-bottom* whaling respectively, which were 36 and 38 ft. long with seven and nine pulling oars (Brown, 1887, p. 241). The standard American whaleboat never got beyond the length of 30 ft. adopted in the 1890's, and I assume this limit was imposed by the requirements of pelagic whaling. A larger, heavier boat would have occupied too much of the ship's length when hoisted on a three or four-boat ship, and would have been more difficult to hoist on the falls: moreover the whaleboat was (and remains today) of extraordinarily light construction, and when hoisted as a dead weight its keel had to be supported on 'cranes' to prevent sagging, so that a longer boat would probably have been liable to break its back even upon the cranes in the stress of weather and of the ship working. But no boats are hoisted in the shore whaling of the

* 'Sulphur-bottom' was the American term for the Blue whale.

Azores. Excellent surf boats, they are launched from the beach by plenty of willing hands, and when their business is finished they are heaved out again. So they have not the same risk of sagging, and therefore another 8 or 10 ft. added to their length means more room to work in a cluttered boat, and still room for an extra man to pull the extra weight and to tend the whaleline: the extra man of an Azores seven-man boat shares some of the duties of the seventh man of an English boat in Scoresby's time—those of 'linesman'.

The other dimensions of a 38-ft. Azores whaleboat are 6 ft. 8 in. in the beam and 2 ft. 6 in. in depth amidships. This may be compared with a 28-ft. Provincetown boat in 1887 which had a beam of 5 ft. 8 in. and a depth of 2 ft. 2 in.

The hull is smooth-sided, that is, carvel built. American boats were clinker built until the 1860's when the smooth-sided hull was generally adopted. All whalemen everywhere are agreed that the Sperm whale is very sensitive to noise, and the carvel built boat is said to make less noise than a clinker-built one when going through the water: J. T. Brown in fact mentions that the name 'clinker' derives from the knock of water against lap-streaking. The hull is double-ended, for as soon as the harpoon is darted or after a thrust with the lance, the boat is cleared from the whale by backing water, and therefore must be able to go astern as easily as it goes ahead. There is no deadwood aft or forward: deadwood aft would impede quick turning on the steering-oar. The keel has no centre-board fitted, and this is a detail in marked contrast to late nineteenth-century American practice, for centre-boards became general in the 1870's. They allowed the sail area to be increased. My impression is that although the present Azores boats have reverted to the earlier method without centre-boards, they seem not to have diminished their sail area accordingly: the mainsail is peaked up until the overtopping gaff is within a small angle to the mast, and, sailing without centre-board, it is necessary for every man to sit right out to windward when close-hauled under this astonishing spread of canvas. Again the special conditions of shore whaling can no doubt explain why the use of a centre-board has been dropped. Since the whaleboats are all beached when not in use, there is always a likelihood, when launching or heaving-up on a shingle beach, of stones wedging in the slot in the keel so that the centre-board cannot be lowered when required. A characteristic of the hull itself is the rounded or canoe bottom, such that the boat rides high and buoyant in the water. The lines of the forward end or entrance are not as fine as those of the run, aft. The boat rises somewhat from amidships towards each end, with the bow a trifle higher than the stern.

As to the timber employed, most boat-builders now use local wood since the imported wood formerly used has become too expensive. The Pico builders appear still to import woods from Scandinavia and America, and presumbaly these are the traditional materials of whaleboat construction—white oak for the timbers, white cedar for the outer planking, and white pine for the platforms, thwarts, and ceiling or inside planking. The local Azores wood for planking is not cedar but a kind of 'false spruce' which I am unable to define further.

Like most of the American boats intended for Sperm whaling, the bottom and sides of the Azores boat are painted white. The top streak or gunwale streak plank is always a bold contrasting colour. In Pico boats it is blue, as it was in most of the Yankee whaleboats. Fayal boats have a red top streak, and for these two islands the distinction is essential, because it will be remembered that Pico has a concession to sail a limited number of her whaleboats from the coast of Fayal. In contrast to the former American custom there is not today much paint used inboard of the gunwale rubbing streak, but the timbers and ceiling, box and cuddy-board (*q.v.*) are varnished: the platforms for the harpooneer and the boatheader are neither painted nor varnished lest these men slip. The boats are immaculately kept, and a delightful feature is the use of polished strips and turned rods of Sperm jaw-bone for the gunwale rubbing streak and for the sail-cleats. Scrimshaw work employed in this

way, at once decorative and functional, sets off the handsome appearance of these boats. In the whaleship days sperm bone and ivory was sometimes used for a few of the blocks, belaying-pins and other small gear in working the ship, but I have nowhere found in the literature any mention of scrimshaw fittings for the whaleboats, perhaps because these boats of the pelagic fishery (apart from those smashed in the chase) got much knocked about during long voyages with limited shipwright attention, and so were not decorated, as they could not be expected to last as long as those of the present shore whaling venture.

Following the regulations for fishing vessels generally, the Azores whaleboats have painted on their bows identity letters and numerals, suffixed by 'P.B' for *Pesca da baleia*, or, simply, 'B' for *Baleia*. Each boat has a name on the quarter, sometimes done in a gilt scroll. Favourite names are those of saints or of relatives of the whaling owners. By this naming the boats acquire an individuality denied to the anonymous boats carried in the whaleships. As an example of a shore whaling fleet there are preserved in Table 8 (p. 326) the names of all the whaleboats and motor tow-boats sailing from Fayal in 1949, just as Table 2 preserves in another order of size the registry of whaleships from a vanished era.

In its furnishings the present-day whaleboat keeps all the distinctive features of the nineteenth-century model. The stem bears a conspicuous groove, the chocks, where the whaleline runs when fast to a whale. The chocks may have a bronze or brass roller, or be bushed with some metal like lead, but sometimes in Azores boats the chocks have a plain wood surface without liner. Abaft the chocks a small triangular space, decked in and sunk below the gunwale, is called the box. When the boat is hunting and the gear is in readiness, the box has coiled upon it several fathoms of the forward end of the whaleline: this box-line, or box-warp, is the slack necessary when darting the harpoon, which is fastened to the end of the box-line. Limiting the after edge of the box is a sturdy cross-plank set at gunwale level. This is the clumsy cleat or thigh-board, its special feature being a semicircular notch off-centre, where the harponeer braces his left thigh when he stands up to dart the iron. Occasionally in Azores boats the notch (which is sometimes padded) is not off-centre but placed in the fore-and-aft line, presumably for the convenience of a particular harponeer who can manage a left-handed or right-handed dart with equal ease (Plate XIII). A little abaft the thigh-board on either side there are the bow-cleats, two substantial fairleads swept up from the wood of the gunwale and directed forwards. These bow-cleats are used in 'bowing-on a whale', that is in veering the boat to tow parallel to a fastened whale by bringing the taut whaleline from the chocks to the bow-cleat, so as to get in position to use the lance. Bowing-on is a job for the bow-oarsman. In a boat fast to a whale, the bow-cleats are also a safeguard, preventing a whaleline which may happen to jump the chocks from sweeping the boat. This is especially important in the Azores where, so far as my experience goes, the chock-pin and kicking-strap seem not to be employed, although they were universal in the old fishery. The chock-pin was a slender wooden pin which helped to keep the whaleline towing in the chocks. The kicking-strap was a short length of rope secured to each end of the clumsy cleat so that the whaleline, stretched along the mid-line of the boat, passed under it. A line which had jumped the chocks and had wrenched free of the kicking-strap would be arrested at the bow-cleats. A third use for the bow-cleat, port or starboard, is as a fairlead for the line when ranging alongside a dead whale in order to reeve the towing-strap (p. 323).

In an Azores whaleboat there are six thwarts placed and nailed upon the risings, that is, the top planks of the ceiling on each side. Proceeding aft, the thwarts may be named, harponeer, bow-, midships-, line-, tub-, and after-thwart, according to the oarsmen who occupy them. The linesman actually shares the tending of the line with others (the tub-, and after-oarsman), but this is a convenient nomenclature. The American six-man boat had five thwarts, for there was no linesman. The seventh man of the Azores boats, the officer or boatheader, called *mestre* in the Azores, has only standing room

for he manages the great steering oar: when sailing and using the tiller, and at times apart from the more urgent moments of hunting, the boatheader often finds a seat on the cuddy-board. When going on a whale (p. 328), and at most times when handling the steering oar, the boatheader stands on two projections from the risings, called the standing-cleats, so as to get a 'longer view'. The bow-thwart is also the main-thwart and is specially strengthened, being dunnage all the way across, that is, the space on the thwart between the two sets of thwart-knees is planked-in flush from side to side, so that the thwart effectively comprises two thicknesses of plank: the other thwarts have one knee to each side and are dunnage only on the side where the oarsman sits, giving him a flat seat. The strengthening of the main-thwart is to support the mast-hinge. This consists of a hinged tabernacle for the mast, with step below, which was introduced in the late nineteenth century so that, when going on a whale under sail, the mast and sails can be struck with the utmost despatch as soon as the harpoon is darted. From the level of the main-thwart forward into the eyes of the boat, and covering the lower planks of the ceiling, there is a platform which may be called the harponeer platform, where the harponeer stands to dart his iron and afterwards to lance the whale. (It will be seen on p. 330 that in the Azores the boatheader does not come forward to lance the whale as he did in the American whale fishery.) Aft there is a short boatheader platform similar to the forward one. It is on the boatheader platform that slack line is coiled when hauling up to a fastened whale. The stern of the boat is decked across at gunwale level by the cuddy-board.

Projecting upwards from the cuddy-board, off-centre towards the starboard side, is the most striking feature of a whaleboat. Some 8 in. high and shaped like a silk hat, this bollard (so-called in the old English Greenland fishery) is the loggerhead (Az. *logaête*, *logaiéte*) around which the whaleline from the after line-tub is taken, afterwards passing between the rowers down the fore-and-aft line of the boat and thence either to the box to be coiled there as the box-line or, in a boat fastened to a whale, through the chocks and so outboard. At the loggerhead the whaleline is controlled: when the sounding which follows the initial dart is exhausted then a turn or so round the loggerhead checks the slackening line: whilst the whale is towing the boat the line is snubbed here, or paid out as required: when the whale begins to tire and the boat hauls forward for the lancing, then slack line is taken in round the loggerhead. It is managed by the boatheader. After a little service the loggerhead acquires a considerable groove round the base, worn by the smoking friction of the line. Taking such strain, the loggerhead is very securely fastened: its foot extends down to a tapered insertion in the keel, and for additional strength there is provided on the cuddy-board a sort of king-plank with a curious flowing curve, the lion's tongue or loggerhead strip.

The Azores whaleboat is never hoisted, and therefore no lifting lugs are fitted fore and aft, such as were universal in American pelagic whaling.

Towing behind the motor-boat. For towing from the coast towards the sighted whales, or for short tows during the periods of hunting, each whaleboat has a long hemp towing-warp, fastened in the boat by a wooden towing-toggle jammed under the clumsy cleat. Whilst towing, the warp is tended by the harponeer, who uses a corner of the lowered jib for partial shelter from the drenching spray, for the motor-boats tow at speeds around 16 knots. The boats are either towed one, two, or three in line astern, or else in tandem, when they are veered by the boatheaders at their tillers.

In American whaleboats working from whaleships on the high seas there were, of course, no power boats generally employed, and the only line comparable to the Azores towing-warp was the boat-warp or painter.

Sailing. The present-day Azores whaleboats, at least all that I have seen, are rigged with gaff mainsail and jib, the latter either loose- or club-footed. Mention has already been made of the astonishing sail area carried by these boats without centre-boards. The gaffsail rig with jib, although the customary American

Table 6. *The whaleboat. Main construction features and complete equipment of a late nineteenth-century American whaleboat fitted for Sperm whaling compared with those of a present day Azores whaleboat*

Gear or employment	Late nineteenth-century American whaleboat	Present day Azores whaleboat
The whaleboat	Length *usually* 28 or 29 ft.	Length 30–38 ft.
	Centreboard	—
	Bow chocks	Bow chocks
	Bow box	Bow box
	Thigh-board	Thigh-board
	5 Thwarts	6 Thwarts
	Mast-hinge on bow-thwart	Mast-hinge on bow-thwart
	Cuddy-board, aft, *with* Loggerhead	Cuddy-board, aft, *with* Loggerhead
Towing behind the motor-boat	(1 Boat-warp or painter)	1 Towing-warp 1 Towing toggle
Sailing	Mast	Mast
	Mainsail boom and gaff, *or* Yard and sprit-yard	Mainsail boom and gaff
	1–3 Sails, *usually*, mainsail and jib	2 Sails, mainsail and jib
	5 Paddles	6 Paddles
	Rudder	Rudder
	Tiller	Tiller
Pulling	5 Pulling oars	6 Pulling oars
	4 Iron spur rowlocks	6 Iron spur rowlocks
	1 Tub-oarlock	—
	1 Steering-oar	1 Steering-oar
Hand harpoons and lances	6 Harpoons (mounted toggle-irons)	4 Harpoons (mounted toggle-irons)
	4–6 Sheaths for harpoon heads	2–4 Sheaths for harpoon heads
	1 Boat-crotch	—
	3 Short-warps, each 4 fm.	2 Short-warps, each 4 fm.
	3 Hand lances, mounted	2–3 Hand lances, mounted
	2–3 Sheaths for lance heads	2–3 Sheaths for lance heads
	3 Lance-warps	3 Lance-warps, each 8 fm.
(Firearms)	*Usually*:	
	1 Shoulder-gun	—
	1 Watertight lance-bag, *containing*	—
	4 Bomb-lances	—
	1 Darting-gun, rigged	—
Tubs, whalelines, and accessories	2 Line-tubs, one large and one small, *containing* 2 Manilla whalelines, one 225 fm. and one 75 fm.	2 Line-tubs, of equal size, *containing* 2 Hemp whalelines, each 120 fm.
	2 Tub covers	2 Tub covers
	1 Drug	—
	1 Blackfish poke	—
Tending the whale line	½ doz. Chock pins	—
	1 Kicking-strap	—
	2 Nippers	*Usually* 2 Nippers
	1 Boat-bucket	1 Boat-bucket
	1 Piggin	1 Piggin
	1 Boat-hatchet	1 Boat-hatchet
	2 Boat-knives	2 Boat-knives
Reeving the towing-strap	1 Boat spade	1 Boat spade
	1 Grapnel	1 Grapnel
	1 Boat-hook	*Sometimes* 1 Boat-hook
Waifing the whale and signalling	1–3 Boat-waifs	3 Boat-waifs
Equipment for survival at sea	1 Boat-keg	1 Boat-keg
	1 Lantern-keg, *containing*	1 Lantern-box, *containing*
	Lantern	Lantern
	Matches *or* tinder-box	Matches
	Candles	Candles
	Hard bread	Hard bread
	Pipes and tobacco	—
	1 Boat-compass	1 Boat-compass
	1 Small roll of canvas	1 Small roll of canvas
	Paper of copper tacks	Paper of copper tacks
	Sometimes 1 Foghorn	—

rig of the 1890's, was not universal in the Azores at the end of the last century, for Richard (1936) has a photograph taken off Fayal in 1888 which shows lug-sailed whaleboats. By that time the American whaleboats had acquired centre-boards, and the lugsail and spritsail (common in these boats in earlier decades) had become largely outmoded and replaced by the gaffsail and jib. Cleats (Az. *clîtos*), inboard of the gunwale and on the cuddy-board, are provided for managing the main sheet, since a horse fixed across the cuddy-board would interfere with the free passage of the whaleline. The boatheader is in charge of the main sheet, but may delegate this to the after-oarsman at times. The bow-oarsman manages the jib sheet. When going on a whale under sail, the jib is always lowered before the harponeer stands up to strike, so that he may have room for the dart.

Conforming with late nineteenth-century American practice, the Azores whalemen employ sails whenever there is sufficient wind. These permit not only the greatest speed in the conditions prevailing, but also a quieter approach than is possible under oars. It is an everyday practice to go on a whale with mainsail set until the moment the harpoon is darted. As the iron fastens in the whale the stays and halliards are loosened, the mast is unstepped and lowered aft on its hinge, and the spread of the mainsail is bundled under control until gaff, sail, mast and boom (Az. *bûme*) can be quickly lashed together with the main sheet, and all stowed so as to project from the boat over one quarter and leave a clear run for the line, which, from the moment of fastening the whale, has been leaping after the harpoon along the length of the cluttered boat. There is no need to emphasize the cool boatwork necessary to conduct this operation, since once to foul the running line whilst struggling with mast or sails can mean serious or even mortal injury.

Whenever a boat is sailing after a sighted whale, the crew employ paddles to lend more speed to the boat. The paddles, betraying their Red Indian origin by their shape and the way they are used, number six, one for each oarsman. Each man paddles sitting on the gunwale, facing towards the bow.

Steering when under sail is by rudder and tiller, but, as soon as the whale is fastened and the mainsail is down, it is necessary to unship the rudder and change to the steering oar. The boatheader, already occupied with the line at the loggerhead, must attend to the rudder quickly, so a lanyard is provided whereby the rudder pintels are unshipped from their gudgeons at a single pull, and the rudder then suspended outboard on the port quarter by belaying the lanyard to the cleat on the cuddy-board.

Sailing after a whale in one of these boats, with a fresh wind on the quarter and with paddles plying fast, I have estimated that the maximum speed attained has been about 8 or 9 knots. This is a necessarily approximate and subjective estimate, but I find it agrees with Brown's maximum figure for an American whaleboat under sail. I would agree also with his estimate of 4–6 knots as an average speed when beating up and down in the general sailing of a day's hunting. A Sperm whale is rather slower than the Blue and Fin whales, and my impressions are that when he is on a feeding ground like the Azores he may loiter at the surface, 'having his spoutings out' between soundings, at around 1–3 knots: when on passage he makes about 4 knots: and when alarmed and running (but still a 'loose-fish' not yet fastened) he seldom does more than 8 knots, although this speed can be much exceeded by a wounded whale (p. 331). It will be seen from these approximate figures that a whaleboat sailing and paddling in favourable conditions can hope to overtake even a running Sperm whale if it persists in the chase. In practice this can be achieved more quickly by a short tow from a motor-boat for part of the running chase.

Pulling. There are six pulling oars (Az. *ôars*, *órs*) in an Azores whaleboat. It will be remembered that the American boats had only five. The boat is single-banked and the oarsmen are staggered, that is, there is only one man to a thwart and each man sits the whole width of the thwart from his rowlock so as to balance the great length of his oar. When rowing, the harponeer always sits on the port side but pulls a starboard oar, the bow-oarsman sits to starboard and pulls a port oar, and so on. Over

a length of about 10 in., where it works in the rowlock, each oar is thrummed with a thole-mat: this provision, whereby the creak of the oars is muffled, has been traditional in the American fishery and it is noticeably effective in assisting a quiet approach under oars. The oars are exceptionally long and heavy. Because the boat has a canoe-like plan, the inboard part of each oar when pulling varies progressively in length from thwart to thwart, and therefore the oars have to be of different lengths so that they may strike equally. In a 38-ft. boat there are two oars each of three lengths, 16, 17 and 18 ft., one set (pulling alternate sides) increasing from forwards to midships, and the other set decreasing from midships towards the stern, thus,

	ft.
Harponeer Oar	16
Bow	17
Midships	18
Line	18
Tub	17
After (stroke)	16

The American boats, pulling only five oars, had to work a less symmetrical arrangement of one long and two short oars on the starboard side against two medium lengths on the port side. The longest American oar did not exceed 18 ft., so it is worth mentioning that the 'longest oars used in any service' still survive today.

Iron spur rowlocks are used similar to those which in the late nineteenth century American boats replaced the double thole-pins of the first half of the century. I do not, however, recollect seeing a tub-oarlock in the present Azores boats. A feature universal in American whaleboats, the tub-oarlock was intended to lift the tub-oar clear of the line-tub in a rolling boat: it took two forms, a dual-purpose, double-decked iron rowlock, the double oar-lock, or a raised wooden oar-lock, the tub oar crotch, which was shipped through a cleat in the gunwale and used as necessary in addition to a conventional spur rowlock.

When a boat is hunting under oars, the whaleline, lying in readiness along the boat between loggerhead and box, passes over the loom of each oar.

The steering-oar or stern-oar (Az. *stanó*, *estanol*) is longer and greater than any of the pulling oars. It measures 22 ft., or sometimes 23 ft., and retains the same length as the nineteenth-century stern-oar. When in use it is thrust out, supported on a sturdy iron steering-oar brace, to the port side of the stern post. Here the stern post and the outer member of the steering-oar brace together share the fulcrum for its sweeping motion. A rope grommet keeps it from jumping the steering-oar brace: this was also the standard American arrangement, although I believe that when Melville was writing, and certainly in the English Greenland fishery, the stern-oar worked simply in a grommet without steering-oar brace. At its inboard end the steering-oar, like the pulling oars, has a fashioned handle, but its loom is distinguished by a further peg handle projecting at right-angles about a foot below the first. This allows the boatheader, straddling his platform or the standing-cleats, to manage the oar with both hands more easily, and (by using the peg as a lever) to expend less effort in keeping the oar blade up-and-down in a sea-way. The steering-oar is always used when the boat is not sailing, that is, when pulling or paddling, and after the boat has got fast to a whale, although it is sometimes boated when the whale is towing steadily. A very ancient feature of English and American whaleboats alike, the great steering-oar survives as the most rapid and effective agent know for turning an open boat. Rapid and considerable turns are essential in coping with the sudden unexpected risings of the quarry, with the several techniques of going on a whale, and with the frequent emergencies at harpooning or lancing when tail-flukes or jaw must be avoided. The oar is also usefully employed for sculling the

boat, particularly in the confined water of landing places where sometimes there is scarcely room for oars in the transit between launching slip and motor tow-boat.

In the present whale fishery, as in the old days, it is customary, when going on a whale under oars, to boat the oars when within 100 yards or so of the dart, and to make the remaining distance with paddles, since these make even less noise that the muffled oars. The practice is not invariable, for when the chance of securing a dart depends absolutely on haste, as when a whale is thought nearly to have 'had his spoutings out' and therefore be ready to sound, then the quiet approach is sacrificed to speed and the boat completes the distance still under oars. In Plate XV, Fig. 5, where a boat under oars is in the moment of fastening, the whale is actually 'rounding out', that is, arching its back preparatory to peaking flukes and sounding: a moment later and the opportunity for the dart would have been lost. When getting fast under oars the rowers, as soon as the iron is darted, backwater one stroke to clear from the whale and then they peak their oars: this means that they shove the handles of their oars into peak-cleats, holes cut into battens fixed to the ceiling opposite each rowlock. Oars boated in the ordinary way might foul the running line, but with oars a-peak and neatly stowed and forming in fact a guiding trough for the line, the boat can tow after the whale and yet be at once ready, when the whale slackens, to haul slack line and then rapidly get out oars again for a pull alongside to make the lance-thrusts.

When a boat is pulling with utmost exertion to go on a whale, I have seen the boatheader keep one hand only for his steering-oar and, with the palm of the other upon the loom of the after-oar, lend his weight to every stroke taken by that oarsman, so that no source of effort might go unspared. This backing of the after-oarsman is mentioned by Melville (1851, p. 363), and by Ferguson in the 1880's (1936, p. 181, posthumous), and it seems to have been a singular way they had in New England because Cheever (1851, p. 132) makes the trick decisive in winning for the Americans a famous race after a whale, rowed between whaleboats from four whalers of France, England, Portugal and America, becalmed in the South Pacific.

Hand harpoons and lances. In the history of seafaring trades there can scarcely be a more remarkable survival than the present use in the Azores of hand weapons to take and kill great whales. Not only in the weapons themselves, but in the precise division of their employment (the harpoon only for fastening the whale by a rope to the boat, and then the lance for killing the fastened whale) the islanders preserve a rigid continuity of technique which has now persisted for a period at least approaching three and a half centuries. The Englishman Thomas Edge in 1611, at 'Greenland' (that is, Spitzbergen) made some of the earliest captures of the Northern whale fishery. Purchas published in 1625 an account of the methods employed by Edge's Basque whalemen during these early voyages. His description (edition 1905–7, XIII, p. 27) remains a precise summary of Azores methods today.

> ...the Harponyre, who standeth up in the head of the Boat, darteth his Harping-iron at the Whale with both his hands, so soon as he commeth within his reach; wherewith the Whale being strucken, presently descendeth...and therefore doe they reare out a rope of two hundred fathome, which is fastned to the Harping-iron, and lieth coyled in the Boat..., and when they perceive him rising they hale in the rope to get neare him, and when the Whale commeth up above water, then do the men lance him with their lances....

One may not trace this practice much farther back because the medieval Basque whalemen and the American Indians encountered by the early colonists, employed mass methods involving numerous boats, and darts, tridents and arrows associated with ropes and 'drugs' (p. 322) for entangling and exhausting the whale: these methods are not comparable with the present survival. But the present-day lance, for length and pattern, remains virtually as it was in Edge's time; and the present toggle harpoon, although a great improvement on the old two-flued iron, can claim a primitive antecedent in the bone-and-sinew toggles of Eskimo whaling and sealing.

The American whalemen seldom used the term 'harpoon' either as noun or verb. They called the harpoon an 'iron'. The kind used today in the Azores is the iron which became standard in the American whale fishery during the second half of the last century. It was invented in 1848 by James Temple, a negro of New Bedford, who made 'whalecraft', that is, was a blacksmith engaged in working from iron the special utensils or 'craft' of the whaling trade. Before this time the harpoon commonly employed was much the same as that known to Edge: it had a fixed saggitate head with two barbs or 'flues', although a one-flued iron became popular in the 1840's, only to be swept away by the superior 'Temple's Gig'. The simplest, besides most successful, of many toggle and other experimental irons invented in that period, the Temple iron has a sharpened pivoted head, which, after being darted in the whale, swings out, as soon as it takes the strain, from its former position along the shaft to one at right-angles to the shaft, and so toggles the harpoon within the whale's tissues. It enters the whale easily, and its special advantage is obvious: it is much less likely to 'draw' than the two-flued iron with fixed flues. The original Temple iron had the toggle pivoted in a channel at the end of the shank, but it soon gave place to the standard form as used in the late nineteenth century in American whaling and in the Azores today. In this the toggle and not the shank is channelled.

Because of the unique place the hand harpoon and lance have in whaling history, the following account describes in detail the craft, the method of mounting them, and their employment in the boat. (By 'mounting' is meant the rigging of the iron or lance to a wooden pole ready for the chase.) The remarks apply equally to the American design and employment, unless stated otherwise. The measurements in Table 7, from mounted craft kindly presented by Reis e Martins Lda., are recorded as typical, but there are of course some few inches or so variation in the sizes of poles and straps in use. Brown (1884) gives a few measurements for the American iron and lance and these agree closely with those in the table, except that the Azores lance-head is rather more than an inch longer than Brown's specification.

The single toggle flue or head of the harpoon is made from cast steel. There is one shallow barb on the back edge behind the keenly sharpened tip. The channelled throat of the flue is drilled to receive the steel pivot, or hinge-pin, borne on the flattened end of the shank. To keep the flue swivelled back parallel to the shank, a small wooden pin, about the thickness of a matchstick and cut off flush with the metal, is fitted tightly into a hole drilled through the flue and the embraced shank, a little below the pivot. As soon as there is strain on the fastened iron, the pin snaps and the flue swings out and toggles the instrument. All harpoons are 'marked craft', that is, the heads are stamped with the initials of the whaling company and usually with the year the harpoon is put into service. Marking craft with the ship's name and date was customary from the early days of English and American whaling, when it served to settle disputes of priority which sometimes arose when boats from rival ships fastened to the same whale. The practice survives in the Azores, where companies in rivalry (p. 334) can also appeal to marked craft. The shank of the harpoon is not made of steel but of tough wrought iron so that it will bend and not snap during the strains and turns of the captured whale. At the end of the shank the hollow wrought iron socket swells gradually to its base so that it looks like a tall cone. The total length of the Azores toggle iron is about 2 ft. 9 in., which is correct for an American Sperm whale iron. In the American Arctic fishery the Bowhead iron was about a foot longer, for the whalemen recognized that Right whales in high latitudes have especially thick blubber so that a longer shank was necessary to ensure that the iron could penetrate the blubber and toggle in the meat.

The American method of mounting an iron, used in the Azores, is the same as that employed in the Greenland fishery in Scoresby's time (1820, II, p. 230), when it was called spanning-in. I watched an iron being mounted at Capelo, Fayal, in 1949, and the whole operation, including the shaping of the pole, took about half an hour. A harpooneer usually mounts his own irons. With a small file the toggle

head is carefully cleaned of rust. The socket of the iron is then completely served with spunyarn or marlin. This helps to jam the iron-strap and prevent it chafing. The iron-strap is a length of hemp rope as used for the whaleline: it was manilla fibre in the late American fishery. The strap is fastened tightly to the shank of the iron by a round turn and eyesplice, so that, when the strap takes the strain of the towing whale, the fastening holds by jamming against the swelling of the socket. The fastening

Table 7. *The hand harpoon and lance. Measurements of mounted craft presented by Reis e Martins Lda. in 1949*

Component	Harpoon ft.	Harpoon in.	Lance ft.	Lance in.
Head:				
Cast Steel		—		
Length		$7\frac{5}{8}$		$4\frac{1}{2}$
Point to barb (harpoon head only)		$3\frac{5}{8}$		
Greatest breadth (without barb in the case of harpoon head)		$1\frac{1}{8}$		2
Shank:				
Wrought iron				
Length	1	11	4	4
Diameter		$\frac{7}{16}$		$\frac{7}{16}$
Socket:				
Wrought iron		—		—
Length		6		6
Diameter at base		$1\frac{3}{4}$		$1\frac{3}{4}$
Total length of iron or lance	*2*	*$8\frac{3}{4}$*	*5*	*$2\frac{1}{2}$*
Pole:				
Local wood		—		
Length	5	9	5	8
Breadth at butt		$2\frac{5}{8}$		$2\frac{3}{8}$
Width at butt		$2\frac{1}{8}$		$2\frac{3}{8}$
Butt ferrule:				
Copper		—		—
Width		—		$\frac{1}{2}$
Strap:				
Hemp				
Circumference		$2\frac{1}{2}$		$1\frac{1}{4}$
Length including becket	6	2	6	6
Seizings:				
Marlin, usually three turns				
Distance of first seizing from socket	1	3	1	10
Distance of second seizing from socket	4	8		
Pole loop:				
Hemp				
Circumference		1		
Distance of insertion from butt		$3\frac{1}{2}$		—
Total length of mounted craft	*8*	*$5\frac{3}{4}$*	*10*	*$10\frac{1}{2}$*

is called 'the hitches' and the way of making it was traditional in the American fishery. Other fastenings than the round turn and eyesplice have sometimes been employed for the hitches in New England whaling in its earlier days (Ashley, 1948, p. 334), but they are not known in the Azores. The pole of the harpoon is a length of local wood about 6 ft. long and $2\frac{1}{2}$–3 in. in section, well chamfered at the edges, and roughly tapered from a more or less square butt to an increasingly cylindrical form and a somewhat smaller section at the socket end. American poles were traditionally of hickory with the bark still on. The socket end is skilfully tapered with an adze and the iron fitted over it and jammed with

a few taps of the pole upon the ground: at no time is the keen-edged toggle allowed to touch any hard surface. At this stage the iron-strap is finished, about 6 or 12 in. from the butt of the pole, with a good-sized eyesplice called the becket. It is here that the box-line will be bent later. The actual mounting of the iron, the fastening of it tight and true to the pole, is accomplished by passing through the becket a stout billet of wood, and then toggling this between a door frame or iron bitts, or whatever improvised holdfast may be handy. The butt is now jammed against a door-step, or something similar, and an assistant bears down all his weight upon the pole until the strap is stretched taut along it, and there stopped down with two marlin seizings, each of three or four turns. The toggling arrangement is now withdrawn and each seizing finished with two copper tacks to jam it and prevent it riding up the pole. Finally a light line is rove through a hole in the butt end and then spliced to make an open loop. A last touch is given to the point and edges of the flue, all the metal parts are well greased, and the mounted iron, now a heavy weapon some $8\frac{1}{2}$ ft. long, is ready for the boat (Fig. 6).

The Azores whaleboat carries four mounted irons, although most of the American boats had six. Two of these harpoons are the live irons, that is, they are attached to the whaleline and will be used in getting fast. They are called first and second irons. The end of that stray part of the whaleline called the box-line, after passing through the loop at the butt, is fastened to the strap of the first iron by a double becket hitch. The significance of the butt loop is to save the harpoon pole: when the whale is struck the iron takes the strain and the marlin seizings on the pole are quickly broken and it slips from the iron socket, but is still held on the whaleline by its loop where it rides loosely and can eventually be recovered. The second iron is bent to a short-warp (Az. *chote-ope*) which is a rope of some 4 fm. and is itself attached by a bowline to the whaleline, where it runs freely. As soon as the first iron is fast the harponeer darts his second, trying to get that fast also. But frequently there may be no time for the second dart before the whale sounds. In this case, to avoid the danger in the boat from a live iron on a running line, the harponeer at once tosses the second iron into the sea, whence it may later be recovered on the short-warp. When the American and English whaleboats lowered for whales, the live irons were placed ready to the harponeer's hand in a special forked rest, called a boat-crotch or iron-crotch (or 'mik' in the English fishery), cleated to the starboard gunwale. I have never seen the boat-crotch fitted in Azores whaleboats, where the irons are simply leaned in a handy position against the thigh-board. The remaining irons, making the four carried, are the two spare irons which are stowed in their traditional place, in the waist of the boat against the port side, lying across the thwarts below the gunwale, and protected by a bit of canvas.

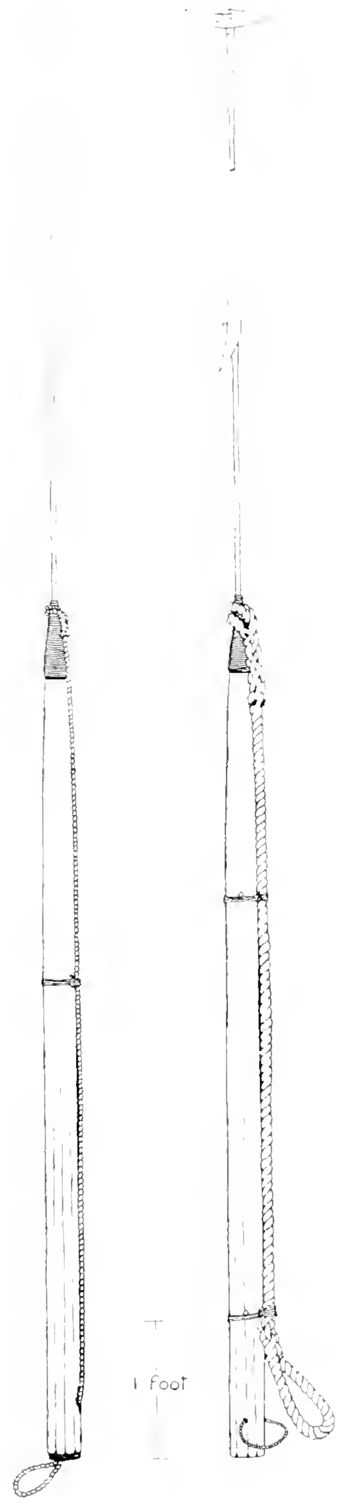

Fig. 6. The hand harpoon and lance. Sketch of the mounted craft specified in Table 7.

The whale lance is a long spear for killing. The cast steel head (called the mouth in the English fishery) is a petal-shaped blade about 4 in. long and 2 in. broad, with a razor-sharp edge all round. Brown (1884) mentions that sometimes the faces of the American blade bore longitudinal grooves, for easier entrance, but I have never seen these

in Azores lances. The shank and socket are of wrought iron, and the former is very long, some $4\frac{1}{2}$ or 5 ft. This lance is mounted on a 6-ft. lance-pole in the same way as a harpoon, except for some finishing details. The lance-strap is seized to the pole with only one seizing and not with two: it is of lighter line, usually $1\frac{1}{4}$ in. stuff. The pole is customarily of the same local wood as the harpoon pole, although in the old American fishery the lance-pole was traditionally made of pine. It is usual to finish the butt of the pole with a copper ferrule. In the lance presented, the pole has a chamfered octagonal section. A distinctive feature is that the lance-strap is not simply finished with an eyesplice behind the seizing, but is led through a 3-in. slot cut into the pole some 4 in. from the butt: the slot communicates with a centre hole drilled from the face of the butt, and through this hole the strap is rove and there given an eyesplice which thus starts neatly from the butt face. This mounting makes the pole clean and unencumbered down its length, and therefore easier to manage. The total length of the mounted lance is about 11 ft (Fig. 6).

In the boat the lance-warp or lance-line is bent to the eyesplice in the lance-strap. The lance-line is a light length of about 8 fm. whereby the lance is recovered after it has been struck or tossed into the whale. Inboard the lance-line is secured to the clumsy cleat. The two or three mounted lances which equip the boat are stowed in a similar way to the spare irons, but the lances are forward on the starboard side, handy to the harponeer.

The keen, bright heads of the spare irons and lances are protected by sheaths of traditional American form. They each consist of two flat pieces of hardwood which close against each other on a leather hinge. Their inside surfaces are excavated to accommodate the head of the iron or lance, and the ends opposite the hinge are tied together and round the instrument's shank with marlin fastenings.

Of lines for the harpoons and lances there are in each boat two short-warps and three lance-warps.

The precise techniques of harpooning and lancing are best postponed until discussion of whale hunting in general.

In late nineteenth-century American boats it was customary to carry certain fire-arms in addition to the hand weapons. It has already been stressed that fire-arms are not today employed in Azores whaleboats, although they found a limited employment in previous years (p. 301). The typical fire-arm equipment of an American whaleboat is listed in Table 6 and the items are briefly described on p. 301.

Tubs, whalelines and accessories. The whaleline in an Azores whaleboat is coiled in two line-tubs of equal size. These are cooper-made of local wood and are each about as big as a large old-fashioned wash-tub, but not so deep. They are stowed on the ceiling of the boat, the waist-tub between the line-thwart and tub-thwart, and the after-tub between the tub-thwart and after-thwart. I believe that two equal tubs like these were at one time used in American boats, around the 1860's and 1870's. Earlier we know from the writings of J. R. Brown, Cheever and Melville that one large tub only was employed. Later than the 1870's, when the centre-board became a standard fitting in American boats, the waist-tub had to be made much smaller, so as to stow to one side (the starboard side) of the centre-board.

The tubs of an Azores boat each contain 120 fm. of line, of $\frac{3}{4}$ in. diameter and of $2\frac{1}{2}$ in. circumference. This makes a whaleline of 240 fm. which is about as long as was used in American whaleboats when a single tub was stowed: American boats with two equal tubs usually coiled 150 fm. in each tub: when centre-boards were introduced it was customary to retain this length of 300 fm. by coiling 75 fm. in the small tub and 225 fm. in the large tub. It is interesting that the Azores whalemen should retain the somewhat shorter line of the first half of the nineteenth century, because they could no doubt make the tubs a little larger and stow more line. But in the event of a fastened whale taking all a boat's line, the attendant motor-launches can bring up more line in a rapid and easy fashion unknown in the old days when only a whaleboat in company could help in this way. Moreover, it is worth remembering

that the Yankee Sperm whalemen of the late nineteenth century might sometimes switch to Northern Right or Bowhead whaling in certain seasons: in the latter fishery a great length of line is desirable because the Sperm whale, despite its reputation as a deep diver, is said not usually to sound as deep as a Bowhead when it is struck and first feels the dart (Gray, 1939). One can make no general rule about the reaction of Sperm whales to the harpoon, but from what I have seen I would say that a typical response is to sound and take out between 150 and 200 fm. of line (or maybe no more than 100 fm.) and then surface and start to run: or occasionally a whale may start to run with scarcely any sounding.

The fibre used for whaleline in the Azores is nearly always hemp. This is a small but striking difference from the old days, because manilla fibre was already ousting hemp from American whaleboats in the 1840's, and was universally employed throughout the second half of the century. The return to hemp, or its retention in the Azores, is superior practice because the best Italian hemp is stronger than manilla and in the whaleboat makes a more pliable rope, coiling easily into the tubs and springing freely from them. Manilla is cheaper than the best hemp, so the strength and pliability of the latter must make it more economical in the long run, unless it is that hemp is more readily available to the Azores. On the other hand I now hear that the islanders sometimes use sisal, which is cheaper than either manilla or hemp but is an unreliable fibre under strain.

The lines are carefully maintained. When the boats return after a day at sea, the lines are laid out to dry upon the rocks. Coiling them afterwards into the tubs requires care and skill, for men's lives may be endangered and a whale lost if the line does not run freely and easily from the tub. The line is coiled down in Flemish flakes, and each flake is put down from the outside inwards, the line being led back along a radius to the periphery to start the next flake. One end, which is the initial end when coiling down, is brought up to project from the rim of the tub, and finished with an eyesplice. Canvas covers, painted to make them waterproof, are placed over the full tubs. When the tubs are back in position and the boat is at sea for whales, the covers are removed and the end from the waist-tub is bent to the eyesplice of the after-tub with a double becket hitch. (In the whaleship days the tubs were not placed in the boat until it was about to be lowered, and usually the covers were removed before the tubs were stowed aboard.) The after-tub, of course, is the first to empty when the line is running. It is convenient to mention here that the whaleline is at no time secured to any part of the boat. It is checked by round turns at the loggerhead only. If the line were made fast somewhere, then a whale suddenly taking all the line might capsize the boat and drag it under before there was time to cut.

The American whaleboats carried two accessories for the line which are not used today in the Azores. These were the drug and the blackfish poke. Both were devices to impede and exhaust the whale. They were survivals from primitive whaling, for the Red Indians employed the drug, and the Esquimaux employed inflated seal skins. The American drug or drogue was a heavy piece of board, sometimes two boards nailed together in a cross, but usually a square or octagon about 15 or 18 in. in breadth: occasionally a small wooden tub was used. The blackfish poke was the stomach of a Blackfish, or sometimes a seal skin, which could be inflated in the boat. When a drug or poke was to be used in a fast-boat (that is, a boat fastened to a whale), the appliance was secured by a rolling hitch to the whaleline outboard of the chocks, and afterwards the line was let go, clear of the boat. Later the wounded whale might be recovered, being encumbered to exhaustion by the drug or poke. In Melville's whaling experience the appliances were usually employed among schools when there was opportunity of taking more whales than a vessel's whaleboats could manage if dealing with them one at a time. J. T. Brown said the drug was also fastened to a calf, 'to attract the mother or other sympathising cows' (1887, p. 268). In the late years of the fishery the drug or poke came to be employed only as a last resort, to try and save a whale which was taking out all the line. Although the drug is now obsolete in the Azores,

it has not long been so: the last mention of *arrastos* among the inventories in the *Estatistica das Pescas* was for San Miguel as recently as 1929. Today drugs are no longer necessary, because the motor-boat can arrive so quickly if a whaleboat signals for additional line.

Tending the whaleline. When the harpooneer has fastened to a whale, the box-line goes away, and the main-line begins to run out from the after-tub, round the loggerhead, down the boat and through the chocks. From the first the boatheader must manage the line, in the beginning to keep it from jumping the loggerhead, and later to start checking it. I have seen a line, after jumping the loggerhead, brought back to it again, leaping round the seared, clenched fists of the boatheader. For checking the line the boatheader may use nippers or hand-cloths, gloves made each of two squares of canvas sewn together, to prevent the skinning of his hands. Meanwhile the linesman sees that the line runs clear from the tub. In the American six-man boat the tub-oarsman attended to this. As the line in an Azores boat flies from tub to loggerhead, the two after-oarsmen dash water upon the uncoiling flakes. They use two cooper-made wooden vessels, the boat-bucket with a rope handle, and the smaller piggin, which has one stave projecting above its rim to serve as a handle. The piggin is properly a bailer for the boat, but it seems generally to be used also for wetting line, and was so used in American whaling. 'Wetting line' is an essential operation. Such is the friction at the loggerhead that an unwetted line may catch fire there, and even a wetted line can smoke. It is well to confirm earlier statements to this effect, since I have seen commentaries on whaling where they were pooh-poohed.

The operations in a fast-boat, like checking line, towing behind the whale, hauling line, and hauling up for lancing, can be reserved for the description of whale hunting. But the tools used in emergency may be mentioned here. It is necessary to 'cut line' for certain mishaps. These are when a man fouls the whaleline, or some part of the boat fouls the line so that the bows pull down and the boat is likely to swamp, or when a boat is stove by a whale and there are men in the water, or when a whale is still towing at nightfall, or simply when some line must be saved from a whale which is clearly taking out all from an isolated boat. For cutting line there are a boat-hatchet and two boat-knives. In the Azores as in the American boat, these are kept in definite ready-use positions. At the harpooneer end, the boat-hatchet is cleated below the port gunwale abaft the thigh-board, and the forward boat-knife is stuck in a leather sheath nailed to the thigh-board itself. The after boat-knife is in a similar sheath nailed to the cuddy-board and ready to the boatheader's hand. A blow with the hatchet is best for cutting rope, and this is specially true in a whaleboat when the line is running, because attempts to hack a running line with a knife will turn the blade. The whaling regulations of the Grémio dos Armadores da Pesca da Baleia require that each boat must carry a hatchet for cutting line in emergency (1925, p. 9).

Reeving the towing-strap. When a whale has been killed the boat is ranged alongside by the line at the bow-cleats, for it is necessary to cut a hole in the head or tail for reeving the towing-strap. A boat-spade is carried for this purpose. This is one variety of the cutting-spades still employed in the Azores for working-up whales (p. 334). The boat-spade is a stout cast steel chisel about 8 or 9 in. long and 3 or $3\frac{1}{2}$ in. wide, usually with chamfered sides, and fixed by a short shank to a wrought iron socket on a pole about 9 ft. long. Chopping the hole is an awkward operation requiring strong arms and a steady balance. It is easier to mortise the hole into one side of the spread of the flukes than into the selected regions of the head, where the parts, though equally tough, are thicker and less accessible from the boat: the flukes offer a good hand-hold for keeping the boat ranged alongside. In the head the hole is chopped through the bulge of the lip of the single blowhole, or, more commonly, through the nib end, that is, through the 'cut-water' where the lower forward end of the junk (p. 336) comes smoothly downwards and inwards to join the margin of the front of the palate (Plate XVI, Fig. 5). Although more tediously accomplished, a hole in the head region is preferable because the whale,

naturally enough, tows better when travelling head first. If the whaleboats of one company are amidst a school and several whales are being taken, the holes are usually chopped both fore and aft, so that several whales can be taken in tow in line astern behind one powerful motor-boat. A grapnel and a boat-hook are usually included in the boat's equipment to assist in reeving the towing-strap through the hole mortised with the boat-spade. The towing-strap may be a short-warp doubled and knotted, or more commonly a wire-rope strop or short chain supplied from the attendant motor tow-boat.

In the American fishery up to the 1860's or 1870's the boat-spade was sometimes employed in a perilous operation called 'spading flukes'. This was a method of 'stopping a running whale' by a single hamstringing blow with the sharp spade, aimed at the tailstock where it receives the insertion of the flukes. Spading flukes was less often employed in Sperm whaling than in northern Bowhead whaling, when the prospect of a fastened Bowhead escaping by a run below the edge of the pack-ice sometimes called for this desperate use of the boat-spade. The introduction of bomb-lances made spading flukes unnecessary so that by the late nineteenth century the practice was obsolete. And I am told that in the Azores today, although the bomb-lance has itself been abandoned in favour of a return to hand-lancing, the use of the boat-spade as fluke-spade has not also been revived and the whalemen no longer deliberately 'fight under the flukes of the whale'.

Waifing the whale and signalling. An Azores whaleboat carries three hand-signalling flags or waifs. It is common practice to use one of these flags for waifing, that is, marking a dead whale. A dead Sperm whale occasionally sinks, when it becomes a total loss, unless it can be held by lines from one or more whaleboats, or from a motor-boat. However, it usually floats, although low in the water and with its corrugated flank awash, and, at a distance, made only a little more conspicuous by the stiffly upthrust flipper. It is therefore marked with a flag, to be picked up when the whalemen's day ends, for the whaleboats and tow-boats will carry on with their hunting after a kill has been made, unless the day is advanced and there are no prospects of further whales. The Azores waifs retain the traditional pattern of bygone whaling: the wooden staff of each, where it is inserted into a slit cut on top of the whale, is notched to make from one to three projections which hold in the fibrous blubber. The Americans sometimes employed a blackfish poke, painted white and on a stray-line, for marking dead whales, but a waif is invariably employed in the Azores.

The primary purpose of the waifs is actually for signalling, and the regulations of the Grémio dos Armadores da Pesca da Baleia (1925, p. 9) insist that all whaleboats must carry three flags, one red, one white, and one blue. Senhor Tomas Alberto de Azevedo has explained their significance to me. A red waif set in the boat summons assistance. For instance the boat may require more line, or may need a tow from the motor-boat: or there may be a forthright emergency, as a smashed boat, or a man injured by a foul line. The white flag is an invitation from the boat of one company to that of a rival company to 'mate', that is, to share the same whale. Companies may only do this in unusual circumstances, for they are vigorously competitive. However, it may happen, for example, that a Pico boat fastens to a whale but is swamped. It is still fast, and by all the rules of whaling owns this whale, although in no position to do much about it. A Fayal boat may fasten at this juncture, and then the showing of a white flag means that each company agrees to go half shares in the whale. A blue flag is a mutual sign of recognition between boats of the same company: it may also signal to a cliff look-out that two or more boats are in company. The American whaleboats carried between one and three waifs. Methods of signalling between the whaleship and her boats differed a good deal: some ships evolved arbitrary codes intended to baffle other vessels which might lower for the same school. But one system commonly used, and described by J. T. Brown in a footnote (1887, p. 257), required three or four coloured waifs and closely resembled the present Azores code. The boats carried flags which were duplicated in the ship, just as the red, white and blue Azores waifs are replicated in the motor-boats.

Equipment for survival at sea. Lest a boat be benighted, or carried far off the coast by a running whale, the Grémio dos Armadores da Pesca da Baleia requires that a lantern and a boat-compass, and water in a boat-keg, and hard bread (ship's biscuit), be carried in all whaleboats. This follows the old-time practice. The Azores boat-keg is wooden, cooper-made, and retains the traditional shape of a low, truncated cone. The lantern, candles, matches and hard bread are stowed in a waterproof wooden lantern-box kept in the cuddy (the space in the stern below the cuddy-board). The lantern-box corresponds to the frustum-like lantern-keg in which these supplies, often with some tobacco and a few pipes included, were stowed in the old days. The boat-compass is kept in one of two narrow wooden drawers sliding below the cuddy-board to port and starboard respectively, and handy to the boat-header. The other drawer contains some canvas and a paper of copper tacks, which can be used for making an emergency patch if the boat is stove by a whale. I do not recollect seeing a hammer in the equipment, and I assume that the boat-hatchet is used for driving the tacks, although Figueiredo (1946, p. 93) indicates that a mallet is carried.

A final item of equipment, sometimes carried in the old American boats, was a boat-horn or fog-horn. I have not seen a fog-horn in Azores whaleboats, and it is likely that the Americans more commonly included a fog-horn when they were Right whaling on coast banks or along the ice-edge where sudden fogs might be expected.

The gear enumerated comprises the complete equipment of an Azores whaleboat. Checked and overhauled daily it is kept in the boats as they lie in readiness in their sheds, or hauled in echelon on the boat-slip. It will be seen that in an open boat so cluttered, 38 ft. long and burdened further with a crew of seven, there is no room for the unskilled or awkward man, especially when the line is running. One may therefore imagine the tight fit in an American nineteenth-century whaleboat shorter by 10 ft., with only one man less, and with all the Azores equipment plus a centre-board and fire-arms.

Whaleboat stations. Generally the whaleboats and motor tow-boats sail from the station where the whales are processed, but the boats serving certain whaleries, namely three modern stations and one try-works station, sail from separate places. There are six of these 'whaleboat stations' in the Azores, and the two at Capelo and Salão on Fayal are described here as examples: the others receive passing mention when try-works stations and modern factories are discussed.

Both Capelo and Salão are remotely situated, being chosen because some small reef offers a little shelter for launching boats on the exposed coast. Capelo is the bigger station and lies below Capelinhas Lighthouse at the extreme west of Fayal. Here the reef turns at an angle to the shore and makes a tiny creek denied to Salão. There are thatched boat-houses along the beach, and a store for ropes and sails. During the summer months the boats are not taken to the houses, but are kept in readiness along the length of a stone slipway into the creek. The crews of the Pico boats which sail from Capelo (p. 298) are temporarily lodged at the station and have their own mess-room, where there are bunks and a table and a store of potatoes and dried fish. A woman comes daily to cook for them. The Fayal men have their cottages in the coast village nearby, but they spend all day at the station in readiness for launching.

The isolation of the little station at Salão in the north of the island is only equalled by that of the Porto do Castelo whalery in Santa Maria (p. 341). The slipway at Salão, built in the lee of a single outcrop of rocks, is reached by a scrambling path down the sheer cliff. There is no beach and no place for boat-houses. On the cliff top, nearly a mile from the coast road, there are two mess-rooms, the respective summer quarters of the Fayal and Pico whalemen.

The whaling strength of Capelo and Salão is shown in Table 8. The two stations are closed in the winter months, when bad weather makes launching impracticable and the motor-boat anchorages

untenable. In winter some of the boats are stored at Capelo, and some are taken to the harbour at Porto Pim, where they carry on whaling when opportunity affords.

The motor tow-boat

The uses of the motor tow-boat in Azores whaling have been summarized in a historical context on p. 301 and some are mentioned in more specific terms in the foregoing account of the whaleboats; they will be referred to again when whale hunting is discussed. At this point it is convenient to interpolate a short description of the motor-boats and their equipment.

Nowadays there are motor tow-boats at all whaleboat stations, in the proportion of one motor-boat to two, or sometimes three, whaleboats (Table 4, p. 306).

The motor-boats are all made locally in sheds or shelters at the principal whaling station of each company. A typical launch is 40 ft. long and 8 ft. in the beam. It is petrol-driven and is both fast and powerful. With no whaleboats in tow, but racing, say, to assist some boat in difficulties, it can attain a speed of 18 knots with ease. It can make satisfactory headway when towing several dead whales: the Fayal motor tow-boat *Cetaceo* (Table 8) can tow no less than eight whales the 15 miles between Capelo whaleboat station and the factory at Porto Pim at rather more than 2 knots.

Table 8. *Whaling fleet sailing from Fayal in* 1949

Boat Station	Boats owned in Fayal		Boats owned in Pico	
	Whaleboats	Motor tow-boats	Whaleboats	Motor tow-boats
Capelo	*Natercia* *Eliza* *Capelinhas* *Santo Espirito* *Rutt* *Maria da Conceição* *Senhora Santa-Ana* *Senhora das Augustias* *Maria Virginia*	*Walkiria* *Cetaceo* *Maria da Conceição* *Orion* *Isolda*	*Senhora do Linault* *Maria Vequene* *Maria Lucinda* *Mester Cardron*	*Horizonte* *Marota* *Cachalote*
Salão	*Senhora da Guia* *Senhora do Socorro* *Carlos Manuel*	*Maria Luiza*	*Poniporo Recreio* *Fatinha* *Maria Adelaide*	*Picarota*

The crew usually comprises an engineman, who is in charge, and a boatman. Unlike the whaleboats, the motor-boats are not hauled ashore, and since several of the stations are on hard, exposed coasts, the motor-boats have to lie at open anchorages which sudden storms can make untenable. Consequently the engineman, who is often an aged and veteran whaleman, always sleeps aboard his craft, so that in emergency he can clear the anchorage and make for the nearest harbour. The engineman's quarters (comprising a bunk and little else) are right forward, and abaft these is the engine compartment which also accommodates the radio-telephone apparatus in those boats in which it is fitted. The cockpit aft has stowage for two drums of petrol, a boat-keg of water, and two spare tubs of whaleline for those whaleboats which may signal that they require more line. There are also wire strops and one or two light chains as towing-straps for the dead whales. On deck the mast is permanently stepped, and is rigged with suitable tackle for a boatswain's chair, so that from time to time, when approaching the reported position of a blow, or when in the midst of a hunt for a scattered and 'gallied' school (p. 328), the boatman may be hoisted to the masthead as a look-out. A sail is not bent, but is carried in case of engine breakdown. Certain items of whaleboat gear are lashed ready to hand upon the deck. These include a harpoon and lance, each mounted and fitted with a sheath. The harpoon provides for a sudden rising, or some unusual event, which might allow the motor-boat to

fasten a whale. But a motor-boat would normally never attempt the harpooning, and the event must be rare for I have not heard of an instance. On the other hand lancing is occasionally carried out from the motor-boat when the circumstances are suitable. Time to the kill can be saved thereby, for a fastened whale running at the surface can be overtaken by a motor-boat before it has tired sufficiently for the fast-boat to draw close enough to lance it. Also a whale which can scarcely be approached by the whaleboat because it has turned 'ugly' with flukes or jaw, may be attacked from a motor-boat using tosses of the lance combined with approaches and retreats at speed. Typically, however, the motor-boat, a towing and escort craft, does not take part in lancing: the lance may be looked upon as emergency equipment like the harpoon. The deck of the motor-boat also carries three waifs for signalling, corresponding to those carried in a whaleboat. Finally, there are a boat-spade and a boat-hook, for the reeving of the towing-strap is not uncommonly executed by the motor-boat, particularly when there are plenty of whales and the whaleboat can best be employed in resuming the chase.

Whale hunting

My experience of the Azores hunting methods is got from two days of twelve hours each spent whaling from the boat station at Capelo, Fayal, on 11 and 13 August 1949. The first day was spent in a motor tow-boat and the second in a whaleboat, and since these were profitable excursions for the whaling fleet, yielding one Sperm whale on the first day and thirteen on the second, the 16-mm. cine-film made at this time includes all aspects of whale hunting. I feel especially privileged to have sailed in a whale-boat since the presence of an eighth man increases the difficulties and dangers of the chase.

A personal account of the Azores whale hunt has been published elsewhere (Clarke, 1949). In the present report it has been necessary to describe some part of the technique of hunting in the previous pages, so as to explain the construction and employment of whaleboats, gear and motor tow-boats. These should be read in conjunction with the following remarks which attempt to record in their proper sequence the details of procedure and the events of the hunt.

Alarm and departure. As soon as the cliff look-outs raise a blow (Az. *blo*), usually in the clear light approaching sunrise, a rocket is fired and within a few minutes, amidst shouts of '*Baleia, baleia!*', the whalemen are running down to the boat-slip or manhandling the boats from their sheds. Since they can expect a whole day at sea they commonly bring personal provisions, bits of bread and cooked fish and bottles of water, and stow these with their jackets and jerseys in the boat ceiling or under the box or the cuddy. The boats are launched and sculled towards the motor tow-boats which sidle in to meet them. When the towing-warps are fast, the launches, each with two or three whaleboats astern, start at speed towards the reported blow, at any distance between 3 and 30 miles from the coast. The time between the warning rocket and departure is not usually more than ten minutes.

Whilst they are being towed, each boat's crew removes the covers from the tubs, arranges the line, and bends on the live irons, making everything ready for the chase. If it is sailing weather the mast is stepped and stayed.

At intervals of a quarter of an hour or so, a motor-boat equipped with radio-telephone will call up the watchers on the cliffs and ask for any revision of the bearing, and for any change in the number of blows sighted. Motor-boats not so equipped watch the cliffs to keep in line the sheets placed there as markers. As she approaches the reported position a motor-boat sends the look-out to her masthead, and as soon as he raises the low, rounded blow, the motor-boat makes towards it, but stops when about a mile away lest the sound of engines should alarm the whale. Immediately she casts off the towing-warps of her whaleboats.

Chasing. According to what wind there is, the boats hoist sail or man the oars, and the chase from the whaleboat begins (Plate XV). The interval between leaving the launch and fastening the whale with the

harpoon may be short or long, from ten minutes or so to several hours, but it is likely to be the longest part of the hunt, often wearisome, and requiring patience to resist the several disappointments which may punctuate it. The chase is likely to take longer if the whaleboats at sea have divided their attention amongst several whales of a pod which have 'gallied', that is, become frightened and perhaps scattered at a good speed in all directions. Of course, the motor-boats, which are seldom far away, assist here by giving short tows after running whales. The latter blow frequently, tend to travel 'head out', and are not easily lost from sight. Occasionally Sperm whales are not 'scary' but loiter at the surface and appear so indifferent that even an engined craft could approach without disturbing them. Such indifferent whales are soonest fastened. But a whaleboat, after a back-breaking pull or anxious work with the paddles, may be nearly on a whale, and the harponeer up and ready, when the quarry rounds out, turns his flukes, and sounds (Plate XV, Fig. 3). A Sperm whale will not sound for less than five minutes, and if he is fresh he may be down for twenty minutes or half an hour, or for even longer periods: there is an extreme case from the Azores where a Sperm whale is said to have sounded for one hour and a quarter. The re-emergence or rising may be in any direction and as much as a mile or more from the position of the sounding. During the sounding interval the boat may drift, whilst the men smoke and talk quietly, or it may quarter the area, tacking and going about or under leisurely oars. (I have mentioned that the men talk quietly, for I have not heard any shouted orders or raised voices in a whaleboat at any moment of the hunt: even in their conversation the whalemen appear at all times to feel the actual or possible proximity of the whale, and therefore the need for quiet.) A keen look-out in all directions is kept for the first rising. Unless at a distance and in a sea-way, this is not likely to be missed by the watchers, and on occasion it may also be heard, for on a still day the first explosive blast of the blow of a Sperm whale is audible up to 250 yards distance. After sounding, a Sperm whale blows many times in succession. Recent data collected on the respiratory rhythm are still incomplete and have not been analysed, but the actual number of blows seems to depend on the size of the whale and the duration of the sounding just completed. This period, whilst the whale is 'having his spoutings out' before sounding, is a good time to close with the harpoon. But the boat, after a burst of strenuous effort, may again be disappointed. According to the narratives of old-time pelagic whaling, the harponeer may also be baulked if the whale 'settles'. By settling is meant an abrupt bodily sinking in the water 'with the apparent rapidity of a lump of lead', and is said to be a sudden expedient of an alarmed Sperm whale which has no time to sound. But I have not myself seen a Sperm whale settle either in the Azores or elsewhere.

There are times, especially in winter in bad weather, when all the whaleboats return after a fruitless day. Usually, however, one or several of the whales reported are eventually fastened or killed.

I have noticed that the whaleboats are careful to avoid the glassy-smooth circular patches, nowadays believed to consist of aerated water, which appear singly at the surface after a whale has sounded, or in succession if he is swimming a little below the surface. The American whalemen also avoided this 'slik' or 'glip', lest by disturbing it they gallied the whale which in some mysterious way was believed to be in communication with its slik.

Fastening. The last hundred yards or so of the pursuit are made from a definite and not a haphazard direction relative to the quarry, and the approach is called 'going on the whale'. It is a time of great urgency and extreme effort in the boat. The men will normally be plying the paddles, having boated their less quiet oars, although if speed means everything they may go on under oars (p. 317); or they may be in any case under sail and paddling (Plate XV, Fig. 4). The boatheader, handling the steering-oar or the tiller, urges to faster time and greater effort by a whispered, '*Força, força!*'. He may decide to 'go on the flukes' or to 'go on head and head', but he is careful to avoid 'getting on to the eye of the whale' that is, approaching the whale on its beam.

These customary approaches, traditional from the American fishery, take advantage of the accepted oblique or sidelong vision of the Sperm whale. The position of the eye is such that the visual angle is certainly curtailed behind, where the blind arc contains about forty degrees on either side of the mid-line. The species is also said not to be able to see ahead, but actually it is still doubtful how good the angular vision is in front, because the head, in spite of its great length and bulk, has hollow-lines about the level of the eyes, and these increase in depth towards the bluff of the forehead. This can be seen in Plate XVI, Fig. 5, which shows the eye and the hollow-lines. Presumably these longtitudinal depressions allow the animal a more extensive forward vision than is generally supposed, at least when travelling head-out. Colnett, in his legend to a drawing of a Sperm whale, made this point as early as 1798; it has again been observed in recent years by Ashley (1926, p. 78). In practice, however, since 'taking the whale head and head' (called *cabeça com cabeça* in the Azores) is a recognized method of approach, the vision immediately ahead must be assumed to be at least ineffectual: we do not in any case know how efficient are the underwater and aerial aspects of seeing in the Sperm whale.

When going on head and head the boat is set towards the forehead of the whale, at first by lining the emergence of the dorsal fin or hump (Az. *ampo*) a fraction to the left of the spout (Az. *espato*) and afterwards, when near enough, by direct glimpses of the bluff of the forehead. When very near, the harponeer stands up, bracing his thigh in the clumsy cleat: the boatheader steers to one side of the animal and then, with a single sweep of his stern-oar, 'lays the boat on' so that the bow turns in towards the whale at a point, if all has gone well, a little behind the back of the head. 'Choosing his chance', but almost in the same moment, the harponeer darts his iron: the men give a stroke or so astern to clear the boat, and the whale is fastened and taking out the line. Going on head and head has the advantage that the whale is more rapidly overtaken because pursuer and quarry are in fact travelling towards each other. The disadvantage does not lie in gallying the whale by rapidly crossing the eye, since this happens in an instant and is immediately followed by the dart: it lies in the likelihood of a too hasty dart striking too far forward on the very tough integument of the head, where the iron is most unlikely to enter deep enough to fasten properly. Presumably for this reason, and for the greater peril which, in my opinion, invests this approach, it is unusual to go on head and head in the Azores. The commonest practice, and one more likely to be favoured by the relative positions of boat and whale during the chase, is to 'go on the flukes', keeping the hump and the spout in line from astern, and making the last approach on the whale's quarter and towards the hump: the boat is laid on with the stern-oar, the iron darted, and the boat cleared as when going on head and head.

The whaleboat is not infrequently laid on so that the bow actually bumps against the whale's flank. I have myself been in such a boat going on 'wood to blackskin'. In such a case the harpoon, which has been poised above the head in both hands with the point directed downwards, is struck into the whale with a movement from the hips which so doubles the harponeer as to threaten his balance. Darted in this way, the iron often buries all its shank to the socket, or 'to the hitches', in the phrase of American whaling. In any case the dart is not a good one unless the iron is 'fleshed', driven quite through the blubber thickness so that the head toggles in the muscle but is afterwards strained against the firm inner surface of the blubber where it is not likely to draw. Besides bumping the whale wood and blackskin (Az. *blequesquine*), it more often happens that the boat approaches so that the iron is darted from a distance of between 1 fm. and 3 fm. The dart caught in the cine-film still (Plate XV) was about $2\frac{1}{2}$ fm. and was successful. Darting even at this distance requires skill and great reserve of strength in a man who is already strained by pulling and paddling. A dart of 4 fm. would be exceptional, were it not that there certainly appear to be 'long-dart men' in the present Azores whaling who can even

exceed 4 fm. (p. 334). The iron is not thrown as one might throw a spear, but rather pitched in a kind of forceful lob, downwardly directed, so as to get maximum effect from the weight of the harpoon as well as from the man behind it. The spot on the whale chosen for the dart may be anywhere on the back or upper flanks between the levels of the umbilicus and the flipper: a dart forward of the hump in the thoracic region is popular because the iron may toggle under a rib and so be lodged with especial firmness. The head presents a solid and hard surface to the iron and so is always avoided.

The second iron is darted immediately after the first, or tossed overboard if there is no chance of another dart.

The manoeuvre of backing water to clear from the whale was accompanied or instigated by the traditional cry 'Starn all' from the boatheader in the American fishery, but in the Azores there seems to be no order, the action taken being automatic.

When there are many whaleboats from the same company at sea, but only one or a few whales, it may happen that more than one boat will fasten to the same whale. Several 'fast-boats' will usually kill the whale more quickly and certainly, although there may be difficulties in boat management.

The fast-boat. In the American whaleboats, the striking of mast and sail (in a boat which had gone on under sail) was partly the job of the harponeer as he went aft to change ends with the boatheader. In the Azores the bow and midship oarsmen attend to the mast and sail, for the boatheader and harponeer never change ends in the present survival, and this is the one detail which distinguishes the existing technique of hunting from that of 100 years ago. To the last days of American whaling it was an invariable rule that the harponeer fastened the whale but did not lance it: he gave place to the boatheader for this operation, and himself went aft to take the steering-oar and tend the line at the loggerhead. He was in fact known as the 'boatsteerer', for the term 'harponeer' was rarely or never used by whalemen. But in the Azores the harponeer keeps forward where he both fastens and lances the whale. For this reason I have purposely avoided using the word 'boatsteerer' which is not applicable to the Azores survival. The dangerous task of lancing calls for greater judgment and a firmer resolution than does harpooning, and the reason for the exchange procedure in American boats is usually given as the need to have the more experienced man, the boatheader (who was one of the whaleship mates), in the more responsible position. But one might argue that no job is more responsible than the line-managing and the steering in a fast-boat. Indeed, the American practice was long ago examined and logically criticized by Melville (1851, p. 299) who held that, instead of further jeopardizing the safety of the boat by running fore and aft in the crowded moment following the dart, the two officers should keep their places, and that the harponeer should mostly be relieved of rowing during the chase, so as to be fresh when called to dart his iron and, later, his lance. The Azores harponeer wields both these weapons, but he also continues to pull an oar. How or when the relinquishing of the American technique came about is not known to me, but there is the fact that the Azores shore whalemen have not had to contend with the question of prestige inherent in the manning of a whaleship and her boats.

As soon as the whale feels the harpoon, he runs away with the line, usually sounding but occasionally in headlong flight at or near the surface. What happens afterwards until the whale is killed may occupy a short or long time, sometimes as little as half an hour or an hour, and sometimes several hours: similarly the behaviour of the fastened whale and the consequent management of boat and line varies a great deal and from whale to whale. Nor can these variations be associated with sex or size of the quarry. What follows is therefore an attempt to give a general idea of the range of procedures and events.

As the whale's pace begins to slacken, the first effort is made to snub the line at the loggerhead. This may rush the boat ahead, but typically it brings the bow down and some water may be shipped,

because the whale often reacts to the resistance by sounding further. So the line is freed and surges out again. With perhaps one tub empty and the other partially so, the whale starts to rise so that there is slack line to haul. The men face forward, straddling the thwarts, and labour to bring in the line which passes between their legs and is coiled down, not in the tubs, but on the boatheader platform. It has nevertheless to be coiled neatly, for in a short time the whale probably starts to run, and all this recovered line must fly out again: a foul turn in the coil at this juncture, or a foot carelessly placed at the boatheader's end, can be disastrous. As soon as the whale slackens, the boatheader snubs the line and the boat goes away at an astonishing speed behind the towing whale which now renews its effort. Captain G. A. Covill (in Davis, 1874, p. 398) claimed that a Sperm whale could tow a whaleboat at between 20 and 25 knots for a short time. This is little, if at all, overestimated, for my impressions, refreshed and confirmed by the evidence of the cine-film, suggest to me a speed approaching or attaining 20 knots, although only for short bursts, and these very soon or immediately after feeling the iron and the strain on it. Towing behind a running whale, called a 'Nantucket sleigh ride' in the old days, may continue for some time, but with intermissions and slackenings and renewals of pace, during which turns are repeatedly put on and taken off the loggerhead to snub or to free the line. At times there is a chance to haul slack line, but as like as not this will be taken out and the tow begin again. Whenever the line is running the boat-bucket and the piggin are employed to wet the flakes as they uncoil.

If the whale looks like taking all the line, then a motor-boat or a nearby 'loose-boat' is signalled to bring up more line. The motor-boat may run alongside and exchange the empty after-tub for a full one, but a neighbouring loose-boat (one not fast to a whale) passes the end of its whaleline to the harponeer of the fast-boat, who secures it outboard of the chocks by a rolling hitch to what remains of the original line: thereupon the boatheader lets go this line, and the former loose-boat becomes fast, whilst the fast-boat becomes loose. Sometimes in the Azores a whale will take the line of three boats, but not necessarily in a deep sounding, for repeated bursts of furious running can take out all this length of line.

Lancing. Eventually the whale slackens enough for the boat to approach for the lancing. Sometimes this happens no more than a few minutes after the boat fastens, but this does not necessarily mean a quick kill, for several lance-thrusts are commonly required, and a lanced whale may start again and tow for a long time and with renewed power before the harponeer can get in some thrusts more taxing to its strength, and in the end mortal.

As the whale slackens the men straddle their thwarts and haul towards him, hand over hand. This can be laborious work when they must fight every inch of the line they win. When fairly near, and if he is now going slowly enough or is by this time stopped, the whalemen can get out oars and pull up to him, often 'wood and blackskin'. But if he is still going pretty strong, the line is brought from the chocks to the bow-cleat, and the boat 'bowed on' to veer alongside the whale, near enough for a thrust or toss with the lance.

The chosen spot is a little behind and above the flipper with the lance directed obliquely forwards, and it is the whaleman's skill and experience to find the 'life' or vital spot in the thoracic viscera. For the whaleman this does not seem to be the heart, perhaps because its thick ventricular walls may tend to close against a cut, sealing for a time the slim wound of the lance-head. The lungs are generally considered as the life, although it is interesting to note that Davis (1874, p. 176) discriminates further, naming the blood reservoir formed by the complexus of blood-vessels lying under the spine and in the neighbourhood of the lungs: these are the thoracic rete mirabile.

The nearness of approach of the whaleboat determines the method of handling the lance. If the harponeer 'gets a set' wood and blackskin, then he may, standing braced at the thigh board and then

with a blow which doubles him like a jack-knife, drive the 4 or 5 ft. of shank 'socket up' into the whale's side. If the whale does not in that moment rear its flukes and sound, a bold harponeer may retain hold of the lance-pole and thrust the weapon vigorously up and down in the wound. I have been present when a lance was 'churned' in this way. Churning can only last a moment, for almost at once as the boat is desperately backed clear, the flukes go up and the whale is sounding and the line running again. Then the whole operation of towing, hauling line, and lancing is repeated. If the boat is bowing-on (and in no enviable position, for it is travelling between the jaw and the thresh of the flukes, the Sperm whale being 'dangerous at both ends') or in an approach under oars that does not end wood to blackskin, the 11- or 12-ft. lance is tossed just as though it were a harpoon and up to about the same distance. Even with a dart like this it is customary to get a good 3 ft. of entrance into the whale. It will be remembered that the lance is fastened to the boat by the lance-warp, so that it can be recovered and tossed or thrust again and again. Frequently the wrought iron shank is much bent between thrusts, especially when the whale jerks away, towing or sounding. The harponeer commonly straightens a bent shank against the gunwale or across his knee, and I have seen a harponeer actually do this between thrusts whilst just laid off and practically still alongside a whale. In the late nineteenth-century American boats there was sometimes a 'lance straightener' provided, a slot cut in the gunwale just abaft the chocks, but I have not seen this provision in the present Azores whaleboats.

A couple of lucky or shrewd blows can end the struggle at the first lancing and within a few minutes, but commonly several approaches are required and several thrusts, interspersed with short tows occupying a period of, say, an hour from the first lancing and sometimes much longer, before the whale goes into his 'flurry'. The present Azores whalemen use none of the bomb-lances which assisted to a quicker and safer kil. both in the la er American fishery and in the Azores decades ago, but the occasional or handy assistance of the motor-boat in lancing has reduced the time to the flurry in recent years in the Azores.

The flurry. The death struggle can occupy a single convulsion after a particularly successful thrust with the lance, but commonly it takes several minutes, when it is called the flurry. Comparing my own observations and first-hand accounts from the whaleship days, the flurry seems to take a similar course in many whales captured with the hand harpoon and lance, and therefore it is interesting as an aspect of behaviour.

The movements of the flurry may be large in dimension but they are carried out slowly, with the labouring exertion of an exhausted animal. The struggle is heralded by the spouting of blood from the blowhole due to the mounting haemorrhage of the lungs. At this stage, called by the old whalemen 'red flag' or 'chimney afire', the respiratory beat is still sufficiently strong for the exhaled air to atomize the blood, so that the blow is a red mist. The whale struggles at the surface describing a somewhat circular path. The head rears more and more from the water, rising at an abrupt angle between 6 and 15 ft. into the air whilst the gape of the open mouth increases. The jaw now clashes shut as the head falls sideways back, making a splashing withdrawal to a few feet beneath the surface. Next the whale rounds out, as though in an effort to sound. First the snout emerges and then the hump, and then the flukes rear out, but when these are still far from the vertical they fall back and smite the water with a report which, on a calm day, can be heard for miles. The head again emerges and pushes upwards, the jaw clashes, and much the same labourings as those described may take place once or twice again. The circular path is maintained, but the exertions become less and less large in scope. The spout of blood is no longer a mist but a broad, low cascade welling at the blowhole. If it has recently been feeding, the whale vomits squid, sometimes very large, in whole or part. So much blood has been lost that the welling at the blowhole has ceased before the last convulsion takes place. The flukes may sweep a little in a slow arc flat on the surface, and the head start to rear once more. Now the

head splashes back, the body rolls out on one side, with the head awash and the jaw gaping and the stout, blunt flipper sticking stiffly upwards. It is dead, 'fin-out'.

A belief of the American whalemen was that the Sperm whale always dies towards the sun, that is, the head, as it rears in the circular path of the flurry, is always directed towards the sun. I have watched the flurry closely in three whales and noticed that this happened on each occasion (Plate XV).

Sometimes in the Azores, if there are several of a company's whaleboats at sea but the immediate pursuit has been for one whale only, the loose-boats will cluster or 'gam' to watch the flurry, before separating or taking tows from the motor-boats to search for other whales.

I have already described the remaining operations of the hunt—reeving the towing-strap through the flukes or head of the dead whale, waifing the whale, and finally towing the whale or whales to the factory (pp. 323–4 and 326).

Accidents. It should be clear from the foregoing pages that open-boat whaling is a dangerous trade. First, there are the perils of the running line, where a man fouled in a stray turn can be mauled through the boat or whisked outboard and under. This happened last in July 1952 when, according to a newspaper report from Lisbon, a whaleman was dragged from his boat by a fastened whale and drowned off Ponta Delgada, San Miguel. Shortly before my arrival at Capelo, Fayal, in 1949, a harponeer fouled the whaleline and transfixed his thigh with a live iron: he was cut free, but died from loss of blood before the boat could reach Capelo. Men are also injured when a whaleboat is smashed or stove by a blow from the flukes of a whale. Boats are usually stove when lancing, less often when fastening the harpoon. Occasionally a sudden rising below the boat can throw it clean from the water: I have been in a boat where a whale has swum less than 2 ft. below the keel. Rarely there are cases reported in the Azores of 'ugly whales' which, stung by the harpoon or lance, turn on a boat apparently with a deliberate intent, when they may even 'jaw back', biting the boat. Senhor Medeiros, informing me of a whale which was taken off Pico in 1943 and yielded a Pico harpoon planted thirty-two years previously, adds that this whale is reported to have fought wildly at both encounters and to have tried to bite the boats. That boats may be accidentally stove by the flukes is an everyday hazard of the fishery. According to Senhor Tomas Alberto de Azevedo there are between ten and thirty cases of smashed boats each year at Capelo alone, although the boats are not often smashed beyond repair. As an instance of a stove boat I may recall that on 25 August 1949 I saw the boat in which I had sailed twelve days previously brought to the building-shed at Porto Pim for repair. It had been smashed whilst lancing a whale. The keel was fractured, all the planking on the starboard side from midships to stern post was smashed in, and the loggerhead had been tossed out and lay over the broken cuddy-board.

Considering the incidence of stove boats at Capelo, which has a strength of about ninety men working thirteen Fayal and Pico whaleboats, it is surprising that there are not more fatal and serious injuries than are in fact suffered. This is partly due to a regulation of the Grémio dos Armadores da Pesca da Baleia which requires that each whaleboatman must sign an affidavit that he is able to swim before he can go whaling. There is a kind of drill which can roughly be followed when a boat is smashed. In a typical case without complicating circumstances, the men jump over the opposite gunwale into the water in the instant that the flukes strike the boat. Afterwards, if the broken boat can be righted or it is simply swamped, the oars are recovered and lashed across the gunwales, supporting the water-logged boat from foundering; and the men, who have clambered back again, wait until another whaleboat or a motor tow-boat arrives with assistance. Nevertheless from one cause or another there are occasional fatal casualties.

Five whalemen were killed from Capelo in the ten years preceding 1949. They were a boatheader, two harponeers, and two oarsmen. This suggests that no special duty in the boat is more hazardous than another. Five fatalities over such a period may not appear disturbing, yet this figure, compared

with the kind of incidence recorded in the old whaling voyages, does not suggest that open boat Sperm whaling is less perilous today, in spite of the ready assistance which the motor-boat can give. But one should remember that, because of the numerous independent companies which in some islands whale in close proximity, the Azores whalemen are given to 'whaling for victory' more perhaps than any bold crew of whaleship days.

By whaling for victory is meant the furious competition, reckless of any danger or consequence, between whaleboats from rival companies attempting to harpoon the same whale. (For centuries whalemen everywhere have recognized that the first boat to fasten owns the whale, no matter what may happen afterwards.) I have been in a Fayal boat racing a whaleboat from Pico, each boat going on the flukes from opposite quarters. As the harponeers stood up the boats approached so close that the mainsail boom of the Pico boat swept the after part of the Fayal boat and advanced almost to foul the mast, yet neither boat gave an inch of way and both would have collided over the whale, or both fastened together with almost certain fouling of lines and boats, had not the whale abruptly sounded as both harponeers were about to dart. I mention this example of 'victorious whaling' to explain my acceptance of incidents reported to me where a rival boat has intercepted a boat about to fasten, whereupon the harponeer of this boat has notwithstanding hurled his iron clean over the rival and successfully fastened the whale. In such cases the harpoon is possibly not darted overhand in the normal manner, but is 'pitchpoled', that is, tossed underhand in a manner recognized but rare in the whaleship days: it has been said that pitchpoling can strike a whale across 7 fm. Whatever the technique, the successful tossing of a harpoon across a rival boat has apparently happened several times, and predominantly in Pico where the companies are (or were until recently) in the sternest rivalry. As a measure of the stature of the Azores whaleman in skilful strength and daring at the present day, it may be mentioned that a similar feat, culminating a race at Delagoa Bay, South Africa, when an American boat fastened a whale across a rival English boat, became a classic and supposedly unique episode in whaling adventure. Apparently first recorded by Cheever (1851, p. 133), it has been widely quoted since. Yet the Azores whalemen have done this more than once, and do it now, only their whaling has been little known.

Saving the whale

In the present year (1953) there are in the Azores only four modern stations equipped with steam winches and pressure cookers. At the other eleven Sperm whale factories (called in this report 'try-works stations') the whales are processed or 'saved' according to the ancient practice. 'Saving a whale' comprises two stages: the whale is first 'cut in', that is, the blubber and spermaceti are removed, and then these materials are 'tried out' by melting in iron pots to yield sperm oil and 'head oil'. It is unfortunate that, although I have everywhere been shown the implements and fixtures used in cutting in and trying out, I have not happened to visit a try-works station when a whale was actually being saved. Under this heading I therefore describe the various stations and their equipment and give an outline of the methods employed. The outline is derived partly by inference from the equipment and partly by conversations with whaling owners and their station hands. I am not able, however, to examine all the details of technique which may exhibit variations from the old American practice. But the Azores whaleboats are not more astonishing survivals than these stations, some of which retain the methods and the very aspect of New England whaleries of the mid-eighteenth century.

Cutting in. The cutting of blubber and meat, and the disjointing of bones, is done with vertical jabs from a cutting spade (Az. *espeide*). The familiar Norwegian flensing knife, developed from the 'strand knives' of the old Dutch and English whalemen, is unknown in the Azores. The cutting spade is, of

course, got from the Americans who, I believe, perfected this British instrument when they developed for their pelagic fishery the spiral method of cutting in shortly to be described, and required for this purpose a long-handled chisel which could be wielded from a cutting stage at deck level and applied to a whale ranged alongside in the water. As will be explained later, these are also the conditions of cutting in alongside a jetty in the Azores, but they are not the circumstances of cutting in a stranded whale on an Azores beach, or of 'working up' on the flensing platform of an Azores 'modern' station: here the whale can be directly approached, and, as Figueiredo (1946, p. 114) has pointed out, the more efficient flensing knife could be introduced as a time-saving replacement: none the less the long cutting spade is certainly used with great skill and effect no matter how the whale is cut in. One form of cutting spade, the boat spade, has already been described. The other forms differ only in detail. The scarfing-spade, used for cutting blubber, is a little wider than the boat-spade: the leaning spade is obviously wider, and is for detaching gobbets of meat from blubber: the bone spade has a long shank and heavy blade for decapitating the head. These varieties can be distinguished at the Azores whaleries (Pl. XVIII, Fig. 1), but they are used rather indiscriminately on the flensing platform at modern stations. Here the lengths of the handles vary from 6 to 12 ft., although longer spades may be used for cutting in at a jetty. A typical cutting spade measured at Porto Pim had the following dimensions:

	ft.	in.
Length of cast steel blade	0	7
Width of cast steel blade	0	$4\frac{3}{8}$
Length of wrought iron shank	0	8
Length of wrought iron socket	0	6
Length of wooden pole	7	4
Total length of mounted craft	9	$5\frac{3}{8}$

There may be mentioned another cutting instrument which is occasionally seen in Azores whaleries although not much used nowadays. Made by a whalecraft firm in Pico, it is like a giant butcher's knife, and an example measured in Fayal had a 27-in. blade riveted to a 19-in. handle. It is larger than the leaning knives used by the Yankee whalemen for trimming blubber pieces, and seems to have had no counterpart in the American fishery, at least after 1800. The 'Pico knife' is something similar to a strand knife on a short handle and recalls knives depicted in a print (Jenkins, 1921, p. 129) of an early Dutch whaler of the seventeenth century when it was customary to tow the Northern Right whale to the ship in some Spitzbergen bay, and then hack off the blubber with axes and knives before transporting it ashore for trying out.

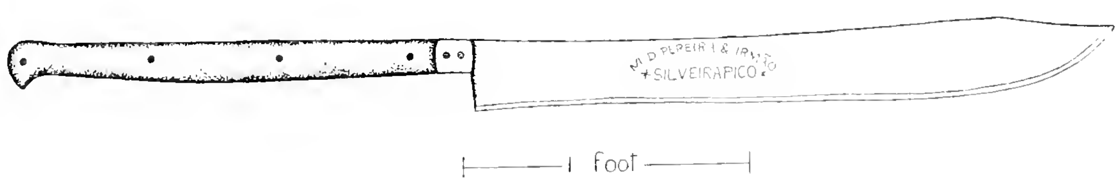

Fig. 7. Pico knife.

The Azores employ two methods of cutting in. The first and more primitive is simply to strand the whale on the beach, or a gently inclined stone slipway, and there remove the blubber. The second is the spiral technique of the whaleships brought ashore, that is, the whale is floated alongside a jetty or quay, and cutting in proceeds as though the jetty were the deck and sides of a whaleship. The four try-works stations at Pico use both methods, according to the number of whales to be saved, the state of the tide and the weather, and the facilities agreed between companies, where several may share the

beach and jetty of each station. At Lagens do Pico, the biggest try-works station, most of the whales are stranded on stone slipways. The two stations at Graciosa and the station at Topo, San Jorge, may use both methods but I have not visited these. All the stations in two islands (Porto do Castelo in Santa Maria, and Negrito and Biscoites in Terceira) merely strand their whales. At Velas, San Jorge, on the other hand, it seemed to me that cutting in is all done alongside the jetty (Table 4). Neither method makes any use of the meat, bones and viscera, and local sanitary regulations require that the stripped carcass be towed out to sea on a suitable ebb tide.

When a whale is cut in by stranding, it is heaved up the beach as far as it will go upon the flood tide. A thick rope warp is secured to the whale's snout, and the end is taken up the beach to a capstan which is securely bedded in rock and cement, and is walked round with capstan bars. The proper designation of this capstan is a 'crab', a whaling term dating from the late seventeenth century: it is the only engine or installation, apart from the try-works, necessary for saving a stranded whale. With the crab it is not possible to do more than strand the whale with its lower sides and tail awash, and the men at the seaward end may be working up to their thighs in water even at low tide when most work is done on the carcass. The whale is stranded with the head end leading, in order to get at the spermaceti organ with the least difficulty. The blubber of the trunk and head is removed piecemeal by two men with cutting spades who work mostly atop the whale. Each is assisted by a hook-man who takes tension with a 3-ft. iron blubber hook as the blubber, in pieces (Az. *piças*) each about 2 ft. square, is chopped out and eased from the underlying connective tissue. For transporting the blubber up the beach there are cooper-made blubber tubs, carried between two men using a stout pole thrust through rope handles. The blubber pieces are very heavy and a second method is to mortise a hole in the piece and so carry it skewered on the pole across the shoulders of two men.

Stripping the head blubber reveals the walls of the spermaceti organ which accounts for most of the enormous bulk of the head. Lying outside the skull and above its rostral part, the spermaceti organ is supported below by the maxillae and limited behind by the maxillary crests. There are two parts within its substantial fibrous walls. The upper part is a reservoir or cistern called the case (Az. *queize*), irregularly traversed by fine membranes and full of liquid spermaceti. A large case may yield ten or more barrels of spermaceti, and there are records of yields exceeding fifteen barrels. The floor of the case is traversed by the wide blowhole canal from the back of the mouth to a distal sac leading upwards to the blowhole on the top left-hand side of the front of the head. Below the case and separated from it by a thick layer of fibres ('whitehorse'), there lies the 'junk' (Az. *janco*) which is divided by transverse partitions into a regular series of compartments or cells: each cell is filled with an areolar tissue loaded with spermaceti so that the cut surface of the junk looks like an opaque jelly. The hollow lines (p. 329, Plate XVI) of a Sperm whale's head seem to correspond for some part of their length with the level of the whitehorse, so that they roughly distinguish the case above from the junk below in the external aspect of the head.

Without tackles the dissection of the spermaceti organ from the stranded whale is a considerable task. The stripped head is cut in and the case broached, when the spermaceti is bailed and scooped into a tub. On exposure to the air the spermaceti soon becomes a soft white waxy solid. When the case is emptied its walls are cleared away so that the junk can be chopped out in manageable sections to follow the spermaceti to the try-works.

Cutting in a stranded whale is illustrated in Pouchet & Chaves's paper (1890, pl. IX). It is a laborious and slow operation, and is accompanied by a certain amount of wastage of spilt spermaceti, although some of this is recovered from the water and beach by 'skimming slicks' with a scoop net, as is done when cutting in alongside. The primitive nature of the survival is obvious, and the following description from Macy (1835) shows how the existing Azores practice compares with New England opera-

tions in an early shore whalery for Right whales at Nantucket about the beginning of the eighteenth century:

The process called Saving the whale after they had been killed and towed ashore, was to use a crab, an instrument similar to a capstan, to heave and turn the blubber off as fast as it was cut. The blubber was then put into their carts and carried to their try-houses, which in that early period, were placed near their dwelling-houses, where the oil was boiled out and fitted for market.

This even seems to have been an advance upon the Azores method, for the crab at Nantucket was clearly used to strip blubber much as a steam winch does in modern whaling. It would in fact be more appropriate to shift the comparison to the early Northern fishery when whales were not always taken to the vessel but were sometimes stranded on a Spitzbergen beach and the blubber hacked off there.

When cutting in alongside a jetty or quay, the whale, floating on its side, is secured fore and aft by head rope and fluke chain to ring-bolts in the stone facing of the jetty. Meanwhile a cutting stage has been rigged above the whale by bracing two stretcher planks outwards from the jetty, and joining them at their outer ends with a third plank, the outrigger, which supports the men using cutting spades. The stretchers are braced from stout wooden posts set in iron hoops fixed to the jetty. The outrigger is fitted with a handrail. For hoisting the blubber there must be a derrick or an elevated beam or gallows to stand duty for a whaleship's main-top and suspend the large and heavy cutting tackles. These are two outsize purchases worked alternately, each consisting of an upper and a lower block with heavy rope falls. If a derrick system is employed, then these purchases take a rather different form, but they are always noteworthy for their great size. I have seen cutting blocks in the Azores which were about 18 in. long and 12 in. wide and 6 in. deep. Cutting in is begun by mortising a hole in the blubber just above the flipper. This hole receives the great blubber hook attached to the lower block of one tackle. I have been shown a blubber hook weighing more than 100 lb.

The insertion of the hook in whaleship days on the high seas was a job for a man sent overboard on a monkey rope, but it can be done at an Azores shore station with less difficulty from a rowing-boat. When the hook is in position, the end of the falls is taken to the crab on the jetty, and the men walk round and heave. This turns the whale slightly in the water so that it lies with the jaw accessible. A strap is secured round the lower jaw and fastened to the second purchase. By hoisting on this, whilst men on the stage sever the throat blubber and mandibular muscles, the lower jaw is disarticulated and got upon the jetty. The jaw and teeth will later provide material for scrimshaw work (p. 347). When the jaw is removed the stripping of the blubber is begun. The falls of the first tackle are eased to allow the whale to resume its former position where it can be 'scarfed' with a cut round the flipper and extending towards the back as two parallel lines 5 or 6 ft. apart. The men heave again at the crab and the first 'blanket piece' is started by wrenching up the flipper and its surrounding blubber, which begins to peel off as a giant strip. The strip rises and the whale turns in the water as the spades extend the scarf and help to tear the blubber from its underlying attachments of loose connective tissue. When the tackle 'comes two blocks', with the lower block hard against the upper one, a man on the jetty takes a boarding-knife (a long-handled, double-edged sword) and cuts a hole at waist level in the strip of blubber now hoisted above him. Through this hole is toggled the strap of the lower block of the second tackle, or else two holes are made and the block is fastened with a chain strap instead of a toggle. When strain has been transferred to the second tackle, a few slashes above the toggle or strap with the boarding-knife cuts the first blanket piece clear, and it is 'boarded' onto the jetty. Then the newly-fastened tackle starts to hoist the second blanket piece. The scarfing, hoisting, and boarding of the blubber continues, and in this way successive blanket pieces are brought to the jetty, whilst the whale turns in the water and the blubber peels off in spiral fashion as a continuous strip down the body. When the tailstock is approached, the strip is severed, and the blubber

of the tailstock is usually secured by first docking the flukes and then unjointing the tailstock and hoisting it to the jetty. I believe that the head is cut off with spades at some early stage in boarding the blubber. It is usually dissected last, or separately. When cutting in the head, a chain strap, the head-strap, is rove through a hole in the nib end (p. 323), and by this attachment the cutting tackle hauls the forehead upwards so that the head lies up-and-down in the water. The spades now free the junk and case from the skull, and afterwards the junk and case are themselves separated. For these operations the spades follow scarfs earlier cut into the head at the time of removing the lower jaw. The junk is hoisted upon the jetty. If the head has been a small one, it is possible to haul up the case also, or even haul up case and junk together without separating them, but the spermaceti from a large case has to be bailed out whilst the case remains upended, hoisted half in and half out of the water. For bailing the case there is a long wooden bucket with a rounded bottom, the case-bucket, and this is rammed into the case with a pole, and then, brimming with spermaceti, hauled out on a whip. This is done repeatedly, until the case is emptied.

This method of cutting in, which corresponds in almost every detail with cutting in alongside a whaleship, may possibly not be employed with such elaboration at some stations like Ribeiras and Calheta do Nesquim in Pico where I recall seeing few special fixtures apart from the crab upon the quay: but my notes are deficient here and it may be that the beam and hoists are only rigged at these stations when a whale is captured. At San Mateus in Pico there are samson's-posts on the quay for tackles (Plate XVI, Fig. 3). The foregoing description refers to the former technique at the old try-works station at Porto Pim, which apparently was not discontinued until the existing modern station was built in 1943. The old try-works station is about 100 yards from the new station and further along the footpath which encircles the base of the steep hill called Monte da Guia. The quay, which was specially fashioned as a cutting platform and is now quite disused, is hewn from the rock and is approached by a flight of rough steps. Ring-bolts and hoops and the rusted bedding for the crab and the legs of the derrick are still to be seen. There is an adjacent stone platform where the head was cut in separately, and the junk and spermaceti carried by a separate flight of steps into the try-house by a separate door. The try-house stands on the cliff above the cutting platforms. The operations at Porto Pim are illustrated in a photograph reproduced by Richard (1936, pl. VII, fig. 2), showing a whale being cut in there in 1888.

Both these surviving methods of cutting in, either stranded or alongside, were used by those emigrant Azores islanders who conducted shore whaling in the bays of California in the second half of the last century (p. 295). The present account may be compared with Scammon's description and illustration (1874, p. 250 and pl. XXVI) of the station at Carmel Bay in, I believe, the late 1850's.

> Under a precipitous bluff, close to the water's edge, is the station; where, upon a stone-built quay, is erected the whole establishment for cutting-in and trying-out the blubber of the whales. Instead of rolling them upon the beach, as is usually done, the cutting tackles are suspended from an elevated beam, whereby the carcass is rolled over in the water—when undergoing the process of flensing—in a manner similar to that alongside a ship. Near by are the try-works, sending forth volumes of thick, black smoke from the scrap-fire under the steaming cauldrons of boiling oil. A little to one side is the primitive store house, covered with cypress boughs....

The Americans were probably first responsible for adapting the whaleship technique of cutting in to shore conditions by employing a derrick or gallows. Among the earliest of establishments so equipped were those dating from the 1830's and operating for Right whales in the bays of Cook Strait, New Zealand. Dieffenbach (1843, 1, p. 51) mentions the scaffold or 'shears' used for cutting in alongside at Te-awa-iti, Tory Channel. These New Zealand whaleries were owned in those days by American and English adventurers, although there were undoubtedly some Azores islanders among the mixed nationals who worked the stations.

Trying out. A necessary preliminary to trying out the blubber is the reduction of the blanket pieces, or the smaller square pieces cut from a stranded whale, into strips of a suitable size for mincing before they go into the try-pots. These strips are the horse-pieces, and measure about 18 or 24 in. long and 6 or 8 in. wide. They are prepared with a cutting spade and 'leaned up' (from any adhering bits of meat) with blubber knives similar to butchers' knives. At certain stations, like Lagens do Pico and Negrito, Terceira, the horse-pieces are temporarily stored in large shallow stone tanks dug into the ground close to the try-works. These tanks are equivalent to the blubber room, a space in the upper hold of a whaleship where it was customary, except when caring for small whales, to send down the blanket-pieces and prepare and keep the horse-pieces before passing them up to the try-works. The horse-pieces, which are heavy enough in spite of their small size, are usually shifted about with a steel spike or prong mounted on a wooden handle, called a blubber pike. With this instrument they are pitched into blubber tubs and so carried to the mincing-horse. This is a stout wooden plank where the horse-pieces are laid and sliced with transverse cuts into 'books' or 'bibles'. The slicing or mincing (which facilitates the subsequent extraction of the oil) is done with a two-handled draw-knife called a mincing knife. The slices are about $\frac{1}{2}$ in. thick, and the 'book' earned its peculiar name because each cut stops short of completely severing the piece, which now resembles a book with forty or so pages. Towards the end of the last century a good many of the American whaleships adopted a simple hand-cranked machine for mincing the books. These mincers may exist in the Azores, but I have not seen any during my survey of the try-works stations. It is in fact unlikely that the mincing machine is used, since it may need a crew of three or four men to make the most of its obvious advantage of speed in mincing, whereas the mincing knife needs only one man; and time is not very important at a small try-works station which does not expect to be 'blubber-logged' by a large catch. The minced books fall straight into the mincing-tub, a large blubber tub across which the horse is laid. From the mincing-tub the books are forked into the try-pots with a two-pronged blubber fork about 7 or 8 ft. long. The try-pots, where the oil is boiled out, are huge cast-iron cauldrons whose size may be judged by the spare pot with implements shown in Plate XVIII, Fig. 1.

The pots are built into an oven of volcanic stone faced with cement, forming an extraction plant called the try-works (Az. *traiol*). Resembling a large domestic copper (as indeed it was called in the early Spitzbergen fishery) this traditional structure arrests the eye, even when no whales are being cared for, and distinguishes some small coastal settlement as a try-works station. The try-works vary a little from one whalery to another, and it is convenient to describe a Pico try-works (Plate XVIII, Fig. 2) in explaining the rest of the process of trying out.

Pico has the most primitive and also the most numerous of the existing try-works. Here they stand exposed without shelter of any kind. There are two pots in rectangular casings in each try-works, except for one single-pot installation among the several at Lagens do Pico. Each pot in the try-works has its own fire-place, usually with a step before the hearth. Iron plates sliding on a horizontal rod serve to close the fire-places, which in whaling language are properly termed 'the arches'. The flues behind each fire-place lead to a common chimney of characteristic shape, squat and conical with flattened sides. When trying out is in progress, the oil melting from the books is kept constantly stirred with a blubber fork or a pike or a spade. The boiling oil is judged to be done when the remains of the books have become crisped and browned 'scraps' or 'cracklings'. The pot-spade is handy for stirring because it can most efficiently scrape any scraps from the side of the pot where they would otherwise burn and darken the oil. Scraps are removed and the oil skimmed with a sieve-pan or scrap dipper, which is a colander made from a pierced circular plate of iron or copper, mounted on a long handle. The scraps, pitched into the arches with a pike or fork, are used as fuel to keep the try-works going, and this practice dates at least from the early Spitzbergen whale fishery when the scraps were

known as 'finks' or 'fritters'. When trying out is completed, a heap of scraps is saved to start the next boiling (Plate XVIII, Fig. 3). The heaps look like discoloured, yellowish-black stacks of old cork floats. A bailer, consisting of a large copper or tinplate can mounted by a wrought iron shank upon an 8- or 9-ft. pole, is used to ladle the boiling oil from the pots into a cooler (Az. *cula*) placed alongside the try-works. At Lagens do Pico the coolers (ancient adjuncts to all try-works since early Spitzbergen days) are simply great cylindrical or slightly conical vessels made of sheet iron plates riveted together. To hasten cooling at Lagens the oil may be ladled from the first cooler to a second or even a third: elsewhere in the Azores I have not seen more than one cooler alongside a try-works.

I have no information on the time taken to cut in and try out a whale in the Azores, but, judging from the whaleship records, a large Sperm whale would probably keep a station with a two-pot try-works busy for three or four days and perhaps longer. There is of course no comparison between these methods and modern whaling on the Norwegian model.

Try-works stations. All existing Azores try-works stations employ the implements and methods just described. The correspondence with trying out aboard an old whaleship is remarkably complete. In a whaleship the brick built try-works was placed just abaft the fore-hatch, and accommodated two pots, although some ships had three-pot works in the middle of the last century. The only different features of a whaleship try-works were a shallow water reservoir under the structure to protect the deck from burning, and the absence of any chimneys until sheet metal ones were introduced in some whalers during the second half of the century. But the Azores try-works stations can most strikingly be compared with the early shore whaleries, with the basically similar operations at Spitzbergen described by Gray, 1662–3 (in Jenkins, 1921, p. 152), and more closely with later New England scenes like that shown in a print reproduced by Scammon (1874, pl. XXIII) of a New Bedford station in 1763, with its try-houses and implements and blubber tubs. And such scenes as Carmel Bay in the 1850's (p. 338) are not even different in detail from some present stations in Pico. There is given below a survey of the aspect and equipment of the various Azores try-works stations as they exist today (see also Fig. 3, p. 297; Table 4, p. 306).

Lagens, on the southern coast of Pico, deserves further mention since it has always held a prominent position and is now the biggest centre for processing whales in the old-fashioned way. Here there are seven companies which own or share an installation of five open try-works. One of these has only a single pot. The open-air factory is built at the expanded end of the breakwater, shaped like a frying-pan, which runs out on a reef sheltering the lagoon of Lagens. Where the breakwater ends, the sea-ward side is clear to give space for a derrick and room to turn the carts which transport materials. On the lagoon or harbour side, the five try-works extend upon the level upper portion of a broad stranding slip. Low walls, helping to break the wind and sea, join the try-works which are so disposed as to make the nodes and terminals of branching arms formed by the walls. In this way three or four working spaces, each with a crab and flanked by try-works, can handle separate whales hauled to the common slip (Plate XVI, Fig. 2). Opposite the factory, across the harbour, there are six whitewashed boat-houses and two launching slips, each of the latter providing for the whaleboats of a group of three boat-houses. In the harbour the motor tow-boats lie at anchor. Elsewhere on Pico the installations are more modest. West of Lagens the little village of San Mateus has a single try-works with a large square tank as cooler, built on the rocky beach against the foot of the sea-wall. At San Mateus the coast road so hugs the shore that whaleboats have to be manhandled from a boat-house across the road: they are afterwards launched from a slipway which is a mere slit in the reef. Whales may be stranded at this slipway or cut in alongside a rough quay built against part of the reef (Plate XVI). To the eastward of Lagens there are two isolated villages, Ribeiras and Calheta do Nesquim, very similar to each other as whaling settlements, and clinging to the foot of tall cliffs which in this region

of Pico carry the coast road several hundred feet above the shore. At present there is a zigzag roadway winding precipitously to Ribeiras from the coast road, but I was told in 1949 that two years previously the settlement could only be approached on foot or by pack-mule. Both settlements are much exposed and were severely damaged by a hurricane in 1946. Each has a stone jetty or quay along a reef jutting into the cove and sheltering a small beach where whaleboats are launched and whales are stranded. Whales are also cut in alongside the quay. At Ribeiras this quay has a crab and a single try-works with two pots. The quay at Calheta do Nesquim has two crabs and once boasted three try-works, but two of these were destroyed by the hurricane.

The functioning try-works I have seen in other islands are roofed over or completely enclosed in a shed or try-house. In the old whaleships the try-works were sometimes roofed over, but never completely enclosed.

There is a try-works station at the town of Velas in San Jorge. Velas is the largest settlement in this island, and it may be for health reasons (since try-works belch thick and evil-smelling smoke from the burning scrap) that the try-house at Velas is situated at the end of a short road hugging the sea-wall beyond the main part of the town. Wattle-sided ox-carts carry the blubber here from the quay where the whales are cut in alongside. This wagon transport recalls Obed Macy's description of early shore whaling at Nantucket (p. 337). The two boat-houses at Velas, like that at San Mateus, Pico, are across the road from the narrow boat slip, and the whaleboats have to be hauled over. San Jorge has a second station at Topo, but I have not visited this and do not know whether the whales are cut in stranded or alongside.

The factory at Negrito, Terceira, is a little more elaborate than at Velas. Negrito is the only try-works station whose boats sail from a separate place: this is the boat station at San Mateus, a little farther along the coast. Negrito has two stranding slips with a raised stone platform between, where a single crab can work ropes through fairleads to either slip. The try-house stands nearby on somewhat higher ground, before a cemented space where two stone blubber tanks are excavated. Within the try-house there is a battery of four pots which are used for blubber only. The spermaceti from the case and junk is boiled out separately in an adjoining open-air try-works whose two pots are made not from cast iron but from riveted sheets of wrought iron. Spermaceti needs a lower temperature for trying out than blubber, and I have been told, rather obscurely, that this explains the use of sheet iron pots. At several Azores stations the case and junk are tried out indiscriminately with the blubber, so that the cooked spermaceti or 'head oil' is not kept separate. But where this separation is carried out, I understand that it is still customary, as in the whaleship days, to 'squeeze sperm' before putting the head matter into the pots. Squeezing sperm means plunging the hands into a tub of the semi-liquid spermaceti and there squeezing them together, so as to remove 'slobgollion', the fine strings and tatters of membrane which are suspended in the spermaceti and which would tend to char in the pots and somewhat affect the quality of the head oil. Turning again to factory details, it may be mentioned that proper storage tanks, excavated from the rock and lined with cement, have been built underground at Negrito: three are for body oil and one is for head oil. Most Azores try-works stations fill the cooled oil directly into the familiar steel drums for shipment. (The wooden oil casks of whaleship days are no longer used in the Azores, and nowadays the coopers who make the line tubs and blubber tubs for whaleboats and factory get the major part of their living from coopering wine casks.) The other try-works station in Terceira is at Biscoites on the north coast, but I have not seen it.

On the island of Graciosa there are two small try-works stations, at Barra and at Santa Cruz, neither of which I have visited.

Santa Maria has a single station in the more sheltered south-east corner of the island at Porto do Castelo, but its equipment for rendering oil is more elaborate than I have seen at any other try-works

station. At the same time (saving the launching slip at Salão, Fayal) it is the most isolated whalery in the Azores. Unlike all others it is not a settlement, having no dwelling-houses, and it is approached only by a zigzag footpath terraced from the red clay and limestone of the sheer cliff and winding down from the lighthouse high above (Plate XVI). The whalemen live at the small village of Maia, a mile to the north, and they have to reach their homes by a roundabout way over the top of the cliff. The try-house lies under the cliff at the head of a small beach where two reefs run seaward, affording shelter in suitable weather for launching boats and stranding whales. A small stone and concrete jetty has been built along one reef and equipped with a derrick, but this is used for loading oil transports and not for cutting in. The crab for stranding whales is installed on the beach below the try-house. This is open all along the front, disclosing a try-works with a row of five pots, each with its own arch. The pots do not need to be separately bailed into the cooler. Instead they are served by two run-offs, channelled into the flush stone surrounds of the pot brims. The oil is bailed directly into the run-offs which are both drained by an iron pipe into a square cooler built of stone. The cooler is, of course, open at the top, but it abuts upon a second stone tank which is covered except for a small square opening fitted with a wooden lid. This is a settling tank into which the oil from the cooler is bailed. From here it can flow by gravity into a large closed storage tank partially sunk into the ground. Finally, the stone top of the storage tank supports a small vertical donkey engine driving a steam pump, so that oil can be pumped as necessary into a large cylindrical metal storage tank installed on a stone platform. In 1949 a second try-works of two pots was being constructed for spermaceti only. Outside the four modern stations and apart from the motor tow-boats, the donkey engine at Porto do Castelo is the only machine I have encountered in the Azores whale fishery: and it is in other respects clear that Porto do Castelo, despite its isolation and difficulty of access, is the most advanced of the old-fashioned stations. The other stations and their try-works are functioning survivals from the last century, but this one has been built, or rebuilt, in recent years.

The only other try-works in the Azores are the four disused ones which have been superseded by steam-powered factories. They deserve brief mention here. In Flores there is one at Lagens which I have not seen. I was informed in Flores that Lagens das Flores is now a boat station and that the only factory is the modern installation at Santa Cruz. On the north coast of Pico, at Cais do Pico, the old try-house contains a battery of eight pots, and this try-works is still kept in good repair against an emergency developing in the steam cooking plant of the new station. The former try-works station at Capellas, a sheltered cove on the north coast of San Miguel, is today simply a boat station, and the slipway is used by whaleboats sailing for the modern factory at São Vincent two miles to the east. In Fayal the old station at Porto Pim, Horta, stands close to the new one. The old boat-houses, like long Nissen huts built in volcanic stone, are still used in winter for the boats brought down from the summer whaleboat stations of Capelo and Salão. The old stone cutting platforms at Porto Pim have already been described (p. 338). The deserted try-house is remarkable for its size and spaciousness. Two try-works each with two pots are ranged against the walls. Accessories I have not noticed elsewhere are conical sheet iron covers for the pots, intended to reduce the risk of fire should a pot boil over. Try-pots in the old whaleships sometimes had similar covers. The cooler here is an immense wooden cask. In one corner there is a wooden pen still heaped with dry and dusty scraps, as though awaiting the next 'affair of oil'.

Working up at modern stations

The islands of Fayal, Flores, Pico and San Miguel each have one steam-powered whaling factory where the whale is heaved upon a flensing platform and there reduced to its blubber, meat and bone for pressure cooking. Unlike most of the try-works stations these four modern stations are placed apart

from the town or village, just as all whaling stations elsewhere in the world, treating the whole carcass, are isolated for hygienic reasons. Working up (that is, saving the whale in the modern sense) is mostly done by a special factory staff, whereas the whaleboatmen at try-works stations do all the cutting in and trying out with no shore-side assistance. Although the cooking equipment is similar to that at any shore whaling station overseas, the Azores modern factories merit description because the platform whalemen have adapted the traditional methods of the cutting spade to the employment of the steam winch, developing an independent technique of flensing and butchering which differs markedly from Norwegian practice.

I am best acquainted with the procedure at Reis e Martins Lda.'s station at Porto Pim outside Horta, Fayal, where most of my time in the Azores was spent. A low isthmus, with the bay called Porto Pim on its west side, runs south from Horta, and the whaling station is built (Fig. 5) where the isthmus abruptly terminates in the high steep sides of Monte da Guia. The flensing platform is partially cut from the hillside and is bounded here by a high unfenced wall at whose top grazing cattle look down upon the platform. A steep cobbled slipway runs down to the water where ringbolts are fixed for securing whales hove to the slip (see Plate XVI, Figs. 5 and 6). A stone bridge spans the slipway and carries the path which leads round the flanks of Monte da Guia to the old try-house farther along the bay. The slipway rises to the flensing platform, which is an enclosed square courtyard with a cemented floor sloping unevenly downwards. Blood is drained from the platform by a system of gutters leading to sumps which open upon the slipway. At the back of the platform in a housing built against the factory wall there are two whaling-winches which can be coupled together: a smaller winch, for working up the head, is fixed in one corner.

The Sperm whales, brought by motor tow-boats from the boat stations at Capelo and Salão, are secured to a buoy lying just off the slipway. Two men in a small boat take a light 'fishing wire' from a whaling-winch to the whale, and in this way it is hauled into the slip (Plate XVI, Fig. 5). As soon as the whale strands at the slip, there are whalemen and local fishermen standing thigh deep in the fouled water to begin stripping blackskin for use as fishing bait. Their scrapers are bits of old iron, or a cutting spade, or simply the clenched nails of bare hands. Meanwhile the platform men are sharpening their cutting spades on a hand-cranked grindstone in preparation for flensing (which cutting in is best called in this context). The multiple heaving-purchases, employing steel blocks and steel wire ropes, are rove; and the moving or lower blocks are laboriously dragged down the slipway and fastened to a large fluke chain around the tailstock. Double purchases may be used on a small whale, but quadruple purchases are required for a large one. Two complete purchases are used for each whale, the standing or upper blocks being stopped to robust concrete heaving-posts bedded in front of the winch housing: the fall of each purchase is taken to either whaling-winch and the two winches coupled for heaving up.

With this tackle the whale is slowly got upon the platform, and at once cutting begins by removing the head at the condyles with a heavy spade, assisted by a wire from the smaller winch. Already this differs from Norwegian practice, which is first to flense all the blubber from head and body before decapitating. The head is dragged to the far corner of the platform, where the whaleboatmen are waiting to flense it and remove the spermaceti organ.

If the whale is a large one, then work proceeds at once on the trunk of the animal. If there are several whales, and these of small or moderate size, then the trunk of the first is heaved to one side, and room made for heaving up the second which is decapitated and similarly dragged to one side. In this way three whales may be worked up together.

Flensing the blubber from the trunk starts with the removal of the post-anal ventral hump (which is all blubber) as a thick strip chopped out with spades from behind the anus to the tailstock. Meanwhile, with the whale lying on its side so that back and belly are respectively left and right, the main

ventral scarf is made as a series of horizontal and vertical cuts. The scarf begins at the anus and is taken horizontally forwards until a few feet in front of the genital slit, where the direction is changed to proceed vertically upwards for about 2 ft. then again horizontally about the same distance, and then downwards, and again horizontally forwards for some 3 ft., when the marking out of a three-sided square is repeated, bringing the scarf at or near the end of the trunk. The tracing of the cut is such that, when the blubber above the scarf is later removed, there remain two square flaps looking like two merlons with a crenelle between in a battlement of blubber. The dorsal or left-hand side receives similar treatment: the dorsal fin and posterior dorsal humps are removed, like the post-anal ventral hump, in a single thick strip; afterwards the blubber in front of the former position of the dorsal fin is scarfed so that it will leave two 'merlons' like those on the right-hand or ventral surface. At this stage the tail flukes receive attention: that fluke raised off the platform is cut off close to its insertion, but the other fluke is conveniently left as a prop to the tail until flensing is further advanced. The flenser now resumes work on the trunk, when all the blubber on the top surface, between the dorsal and ventral scarfs, is removed, most of it in 2-ft. squares with spade and blubber hook, as though a stranded whale were being cut in (p. 336 and Plate XVII). The steam winches are not much used in flensing, although a certain amount of the flank blubber is stripped with their assistance. The flipper is removed last: the senior flenser climbs atop the carcass and clears the insertion of the flipper from its remaining surround of blubber and then disarticulates with his spade the joint between humerus and scapula. Flensing at this stage exposes the white connective tissue covering the meat of one side, with the two blubber merlons standing up left and right (Plate XVII). A hole is mortised in the centre of each merlon, for these flaps will later be used to turn over the remains of the carcass. The first meat to be removed is the ventral body-wall, cut with spade and hook from the anus forwards in a series of transverse slabs or belly fillets. This exposes the intestines. Meanwhile the scapula has been severed from its muscular attachments and dragged off the top of the whale. The great fillets of dorsal muscle or back meat between the neural spines and the transverse processes, are stripped away with the winch as in steam whaling practice elsewhere. In the Azores the winches find more employment in stripping meat and disjointing the skeleton than in flensing the blubber. With the back meat removed, the thoracic cavity is exposed by removal of the ribs, after disarticulation at the thoracic vertebrae with thrusts of the spade. The ribs are dragged out in pairs on a strop from the winch. This completes the work on one side. The carcass is turned over with wires through fairleads left and right to large wooden toggles on the paired blubber merlons of either side, with one wire above the carcass and one below. Working up can now proceed more quickly, for the carcass is much reduced in height and splayed across the platform. The blubber of the former underside now lies on top and is cut out in the usual 2-ft. squares. The flipper goes with the blubber. The belly meat and back meat are stripped away, the scapula removed, and the second side of ribs cut out piecemeal like the first. All that remain are the intact vertebral column, stripped to the bone, and the mass of thoracic and abdominal viscera. With a wire round a fairlead the visceral mass is dragged and slithered down the slipway, whence a motor tow-boat will eventually remove it to the open sea. Neither the liver nor other parts of the viscera were processed at Porto Pim in 1949. The vertebral column is completely reduced by the freeing of each vertebra in turn with the spade.

Work on the head is the one part of the factory operations reserved for the whaleboatmen who come from their boat stations especially for this duty. The custom must derive from the whaleship days when bailing the case and cutting junk were jobs for the boatsteerers. The mass of tissue in the head makes dissection an arduous task: a whale measuring 55 ft. (16·8 m.) has a head about 20 ft. long and nearly 9 ft. high. With the head lying on its side the blubber and tissues between the rami of the lower jaw are first removed: these tissues include the tongue and hyoid apparatus. Next the mandibular muscles

are severed, and the lower jaw is dragged to one side (Plate XVII). At this stage the head blubber is removed, either in square pieces if the whale is small, or in strips flensed with the head-winch. The spermaceti organ is dissected by first opening the case and scooping and draining the spermaceti into tubs. The case is then chopped out piecemeal, followed by the blocks of junk, very much as the head of a stranded whale is cut in. The skull only remains, and this is trimmed of any adhering tissue and dragged to the far corner of the platform to be sawn into pieces.

All sawing is done with two-man forester's saws, for there are no steam bone-saws at the Azores modern stations. The ribs as well as the skulls are sawn up, and there are heavy bone-axes to chop neural spines and transverse processes from the larger vertebrae to get them small enough for the cookers. A last job, which has to wait for some slack period after the platform has been mainly cleared, is to remove the teeth from the lower jaw. An accumulation of lower jaws may in fact be left for days or weeks so as to rot the integuments and tooth attachments and make stripping easier. 'Stripping ivory' is done in the traditional manner, well shown in a sketch made about 1850 and reproduced in Haley (1950, posthumous, p. 199). The tooth row on each side is dragged away complete, adhering to a strip of gum as the teeth are helped in turn from their sockets with a heavy spade. Modern Norwegian practice is similar. The teeth are preserved for scrimshaw (p. 347), together with some sections of the mandibular rami, called 'pan-bone'. The anterior symphysial part of the lower jaw normally goes with the rest of the bone to the cookers.

Work on the platform and in the cooking factory may be continued if necessary by lamplight into the early hours, but the men get very tired, for there are no night shifts or reliefs.

The sequence of operations described is followed rigorously on the platform at Porto Pim. Indeed, the routine nature of the work is one of the few things this and the Norwegian practice have in common. In Norwegian whaling the animal, still with its head unsevered, is flensed by removal of the entire blubber blanket in three strips: the first two strips are simultaneously dragged off with flensing winches left and right, and the whale is then 'canted' by hauling on crossed wires, one secured to the lower jaw and one to the upper flipper, so as to get at the third strip which has been underneath the whale. Overturning the carcass in the Azores is done late in the work and upon what is only the median half of a truncated animal. The Norwegian practice of butchering or 'lemming' a flensed whale is first to remove the head, and then open the body cavity in a single operation by severing the attachments of the ribs and dragging away a whole side of breast by tension at the shoulder: this is in marked contrast to the Azores piecemeal method. In dissecting the head the Norwegian practice again avoids piecemeal methods by detaching the whole 'trusk' or spermaceti organ (case and junk together) as one mass of tissue. The Azores platform men are no less skilful than their counterparts overseas, but the methods employed, and the modest power and variety of the available machinery, make whaling operations at an Azores modern station slower than at a skilled station elsewhere. On a good day in the Azores I have known a platform occupy nine hours in dismembering three whales measuring 52, 42 and 41 ft., and still leave two heads half dissected. A good crew using Norwegian methods can clear a 50-ft. Sperm whale from a factory ship deck within three-quarters of an hour and from a shore station within one hour.

The factory at Porto Pim employs a battery of vertical pressure cookers much like those at any other steam whaling station. The steam is supplied from a boiler fired with brushwood. The wall of the cooking plant limits the rear of the flensing platform, and there is a door near the top of the wall, admitting to an elevated gallery where the cookers can be filled. The pieces of blubber and sawn blocks of bone, suspended on hooks or strops, are hoisted to the door with a steam-operated whip: there are no elaborate bucket-hoists or ramps for this purpose. Cookers for blubber and bone are similar to each other, except that a series of iron grids or spacers are fitted when charging with blubber, so as to

facilitate extraction. The cooked bone is dried and ground into bonemeal. Oil from the blubber and bone is settled and separated by gravity, and then stored in tanks and drums. There were no centrifugal machines for separating oil in the Azores in 1949, and I understand that a good deal of the gravity-separated oil from the modern stations, and of the poorer, darker oil from the try-works stations, is sent to Saccavan on the mainland for refining.

At Porto Pim the meat is not extracted, being dried and converted into meat meal without precooking. No mechanical hoggers are used: the meat is cut for the driers by a small gang with butchers' knives, working at trestles just apart from the platform. After the great fillets have been divided into manageable hunks, these are brought to the trestles and cut into small strips and again into 2½-in. cubes ready for the meat meal plant.

Sperm whale meat is edible, and I have found it as tender and as well-flavoured as properly prepared meat from Whalebone whales, but when fresh it is very dark, the colour of burgundy in reflected light, and many people find this dark colour repugnant. Aboard the old whaleships it was frequently enjoyed pot-roasted or made into pies and meat-balls, but I learn from enquiry that nowadays people seldom eat it in the Azores. It is only in Japan that the meat of this whale is generally eaten.

The modern station in Flores is situated above a small cove rather less than a mile north of Santa Cruz. The station is built upon a cliff, and, although its flensing platform and cooking plant are similar to those at Porto Pim, there is a remarkable feature in the great length (in recollection at least 100 yards, and possibly much longer) of the stone slipway up whose steep incline the whales are drawn between walls of masonry to the level courtyard of the platform (Plate XVI, Fig. 4).

The factory at Cais do Pico is notable for its fine, wide concrete flensing platform sloping smoothly to a brief slipway running out from the shore between two stone piers. At this station there is a steam capstan besides the whaling-winch and head-winch. The cooking plant has four autoclaves for blubber flanked by two larger ones for bone. There are four storage tanks for oil. At Cais do Pico in 1949 the meat was not used, being dumped at sea with the viscera, but the company had plans for installing a meat meal plant. In 1951 the separation of spermaceti and the extraction of liver-oil was begun.

The station at São Vincent, San Miguel, is the oldest of the modern stations, for it has been operating since 1934. Like the last station, it is built close to the beach with only a short slipway. Instead of a blubber-hoist there rises from the platform a broad wooden staircase, with two flights of stairs, giving access to the tops of the autoclaves within the cooking plant. A procession of men and boys, two by two, clamber up the stairs shouldering poles which suspend the blubber pieces and tubs of bone. The plant has oil-fired boilers to supply its eight pressure cookers. The head oil is kept separate, and there is a manually-operated screw press to squeeze out sperm oil from the solidified spermaceti. Meat at this factory is usually extracted in the cookers before it is dried to make meat meal. The cooked meat is stuffed into jute bags and subjected to a simple screw press, and afterwards removed from the bags, minced, and conveyed to the drying plant. There is also apparatus at São Vincent for making blood meal. The blubber staircase and the two manual presses are shown in Plate XVII. The station is served by whaleboats sailing from Capellas nearby, and from Ponta Delgada on the south coast.

Ambergris, scrimshaw, sperm leather and tendons

Besides meat meal and bone meal produced only at modern stations, there are minor by-products which are interesting in themselves although they receive varying attention from the different Azores whaleries and are of scarcely any importance to the economic condition of the industry at the present time.

The search in the Azores for ambergris, a concretion arising in the hind gut of Sperm whales, is as ancient as the recorded history of whaling on the Western Islands ground, for Chaves (1924*a*) says that the State correspondence of 1768 (p. 287) mentioned ambergris. Today, as in past centuries, it is the custom when cutting in or working up a whale to make a routine search for the substance with a few thrusts of the spade into the mass of guts. Usually the search is confined to male whales since most Azores whalemen hold to the belief, for long a tradition in Sperm whaling, that ambergris does not occur in females. Ambergris retains today a market in perfumery, and, although the market fluctuates a good deal, it is still possible for specimens of the right smell, colour and consistency to fetch very high prices. The *Estatistica das Pescas* publishes the value of pieces found in the Azores: the figures naturally vary a good deal, and the authorities would probably not claim that they are more than approximate, but during the 1940's the published value of a kilogram of ambergris was around 1,000 escudos, that is, about £10 at the rate of exchange then prevailing, and this is a possible figure for ambergris of good quality. It is a comparatively rare find, although Chaves (1924*a*) was sufficiently convinced of the possible importance of ambergris to the Azores whale fishery that he suggested that the normal faeces of Sperm whales should be analysed for the presence of ambreine, the characteristic constituent of ambergris.

According to the figures in the *Estatistica das Pescas*, a total of 1208·58 kg. of ambergris have been found in the Azores between 1896 and 1949. When discovered the ambergris is in pieces ranging from small 'rognons' of two or three ounces to very rare instances of huge masses weighing several hundred pounds. A mass found at San Miguel in 1944 is among the largest on record anywhere in the world. According to Figueiredo (1946, p. 176) it weighed 322 kg.: the *Estatistica das Pescas* gives 422 kg. but this is a total annual figure and could include 100 kg. from another whale or whales. In 1949 I was present at two finds of ambergris, one of 19 kg. at São Vincent, San Miguel, on 27 June, and a much smaller one at Porto Pim, Fayal, on 12 July when a 'parcel' of these rognons, weighing 2, 3 and 4 oz., were recovered from one whale. The quality of a find is just as variable as its weight, and these finds were soft, black specimens of poor quality, although they may improve by ageing after removal from the whale.

The art of working teeth and pan-bone into decorative and useful articles is preserved in the Azores, particularly in Pico where scrimshaw is something of a cottage industry in the whaling settlements. An art now perhaps 200 years old, scrimshaw arose from the circumstances of the American whaleman's life, and the word means in its widest definition the handcraft employing Sperm teeth or 'ivory', pan-bone and Right whalebone, metal and South Sea warwood and coco-nut shells, beaten silver coins and turtleshell and mother-of-pearl, and in fact any material incidental to the whaling voyage which could be worked with jack-knife or file or turned on a simple lathe, to while away spells of tedium during the years of cruising. Mostly, however, the whaleman worked with sperm ivory and bone and whalebone, finding these at once unusual and of satisfactory texture: scrimshaw indeed is limited to these materials in the earliest published mention of 'schrimshawing' by Olmsted in 1841 (p. 149), and in the slightly later references to 'mux and skimshander' by Cheever (1851,* p. 136) and to 'skrimshander' by Melville (1851, p. 282). In its proper sense as the spare-time occupation of a whaling voyage, scrimshaw survives and flourishes today in the carved and turned Sperm whale teeth made on Antarctic expeditions by modern whalemen, but the work of the shore whalemen of the Azores better deserves the name, for they got their art direct from the Americans who started it.

The teeth require no preparation beyond boiling to remove bits of adhering tissue, but the pan-bone is chained for at least a year in some shallow part of the sea-bed where the bottom fauna scours it, and

* The second edition (1851) of Cheever's book has been consulted in preparing this report. The first edition (1850) also mentioned 'skimshander'.

the water washes out the oil saturating the bone. The use of scrimshaw in Azores whaleboats has already been mentioned (p. 311). The decorative articles are rather more sophisticated and show more use of the lathe than those made in whaleships. The teeth provide cigarette-holders and pipes, perfume jars, egg-cups, and cups with stems like liqueur glasses, darning-mushrooms, paper-knives and chess sets, seals, signet rings and crucifixes. The chess sets are particularly fine. Articles made from pan-bone include rosary boxes and trinket boxes, walking-sticks, and decorative panels for mandolines. There is a photograph showing a selection of Pico scrimshaw in Figueiredo (1946, p. 188). The amount of finished scrimshaw work is very modest, and is sold across to Fayal where it is mostly bought by visitors on the fortnightly steamer.

The most characteristic scrimshaw articles of the old whaleship days were neither carved nor turned, but were simply engravings or graphics (the best being of high artistic accomplishment) done on polished sperm teeth and depicting a variety of scenes, usually violent moments in the whale hunt or sentimental subjects of home and affection. I have seen none of these graphics in the Azores, but I found recently in London a scrimshaw tooth, shown in Plate XVIII, which seems to be a direct link with the days when Portuguese islanders sailed in the American ships and learned their present trade of Sperm whaling. As scrimshaw the tooth is undistinguished, the subject being conventional and the execution crude. Above a whaling bark flying the American flag, there is a dove of peace (a common motif in scrimshaw) clutching in its beak a streamer bearing the name *Manuel Ballrros*. *Manuel* may be Portuguese, but it is the surname which is arresting, because so unlikely. The suggestion is that this tooth was engraved at sea during the last century by an illiterate Portuguese whaleman, either Azorean or Cape Verder, who was assisted by his messmates to inscribe, with indifferent success, their phonetic rendering of his spoken *Manuel (dos) Baleieros*, 'Manuel of the Whalemen'.

Sometimes the unworked bones of Sperm whales are put to homely and everyday uses. Figueiredo (1946, p. 190) shows sections of jaw-bone used as gate-posts to a field of maize. I have seen door lintels of sperm bone, and also comfortable stools made from upturned vertebrae furnished with wooden legs and back-rest.

On the island of Pico, but not elsewhere, the skin of the Sperm whale is made into leather. In other parts of the world the tough skin of the penis of the great Whalebone whales is sometimes saved because it can be tanned to a handsome leather; and there is a regular industry for making leather from the skins of the Beluga or White whale (Vladykov, 1944, p. 149) since the skin of this dolphin is well supplied with longtitudinal fibres and, in fact, makes the strongest shoe laces obtainable. But leather-making from the skin of the ordinary body surface of a great whale seems to be practised nowhere except in Pico and possibly in Japan, where they tan a certain amount of whale skin from some unspecified part of the body. In Pico the craft is apparently indigenous and not a relic of American whaling, for I have seen no mention of the tanning of whale's skin in the old narratives. Sperm whale blackskin when fresh is soft and friable, and to the ordinary eye appears quite unsuitable for leather-making, yet I find the finished material to be a brown, tough and durable leather, resembling unworked shoe-leather from cows' hide, although perhaps a little less pliant.

Senhor Joaquim José Machado of Lagens do Pico has kindly described how the sperm leather is made. The skin is mostly selected from the head because here it can be stripped with the least attachment of underlying blubber. The strips of blackskin are first steeped in a tub of lime which loosens the adhering blubber and makes removing it easy. Tanning is the next stage, the skin being placed in an infusion of bark from the *faya*, a beech-like shrub, *Myrica faya*, which gave Fayal its name and which is also common in Pico on the foothills and near the coast. After tanning, the skin is pressed through rollers to remove moisture, and then placed in the sun to dry. The leather so produced is about 6 mm. thick, which means that the skin does not diminish in thickness during the conversion into leather.

Pico seems never to have exported any of its sperm leather, and very little of it is made today, perhaps because the whalemen are not so poor as they were. But sperm leather was formerly widely used for making the soles of shoes, and for the rough sandals worn by Pico men. (The surfaces of Pico are so severe that it is the custom to go shod, whilst peasants and whalemen in other islands go barefooted.) Senhor Machado says that a sperm leather sole lasts for six months, which is very good wear on Pico lava and cinders. Complete shoes can be made by using uppers tanned from the skin of large foetal whales. In former years the skin of the adult penis made uppers for durable leather sea-boots.

The extraordinary strength and flexibility of tendons and connective tissue fibres from the Sperm whale make their use widespread in the Azores. At those modern stations which have a meat meal plant, the tendons have anyway to be pulled from the giant fillets of meat, otherwise they would clog the machinery. They are not discarded, but are saved and used for lashing the yokes of the ox-carts which are still the customary transport of the archipelago. The thick, round tendons from the tail are made into whips. Below the blubber there are layers of parallel connective tissue fibres which are best developed in the head, where they enclose the spermaceti organ as beautiful, glistening sheets, closely composed of flat ribbon-like fibres, each several yards long and less than $\frac{1}{2}$ in. wide. These fibres also are used for lashing yokes, but more especially for lacing and joining machine belting.

The whalemen

The life of the Azores shore whalemen has changed little since the days when their forbears shipped with Yankee masters for the deep-sea voyage. Their dress has not changed at all. This is J. Ross Browne's description of his Azores shipmates on a whaling voyage (1846, p. 33);

> The Portuguese wore sennet hats with sugar-loaf crowns, striped bed-ticking pantaloons patched with duck, blue shirts, and knives and belt. They were all barefooted....

Today most whaleboatmen still wear the wide-brimmed straw sombrero and the trousers of striped bed-ticking, the latter with neat and extensive patching which is itself a reminder of the old whaling life when old clothes had to be kept together during a prolonged voyage, and men became experts at ‘a patch over a patch, and a patch over all’. In the boats and on the flensing platform the whalemen still go barefoot.

At some at least of the whaling settlements, as at Californian settlements in the last century, the whaleboatmen receive no wages but are paid on the ‘lay’ system, which is a direct survival from the whaleship days when each officer and man, according to his station, received an agreed share or lay of the net profits of the voyage. At an Azores whalery the owners may take half the profits, and the other half be divided amongst the whaleboatmen at an annual pay-off, so that the boatheaders, harponeers and tow-boat enginemen get two shares each for every share of the ordinary boatman. The shore-side staff at modern stations, that is, the platform and factory workmen, seem to receive fixed salaries and a bonus on the oil: I believe there are some whaleries where the whaleboatmen also are paid like this, instead of receiving a lay. Even the ‘slop-chest’ system of issuing clothing and other goods, by debits to the pay-off, is preserved in the Azores, for at Porto Pim (and probably elsewhere) the whalemen go to one shop, the *casa dos baleieros*, where they have a year's credit for food, clothing, wine and oil.

Most of the whalemen and their families till a patch of land for maize or vines, keep a cow or goat and some chickens, and do a little fishing when they can, to help out their earnings from the whale fishery.

The whalemen are devout Catholics, and every Azores whaleboat sails with one or two sacred pictures in frames secured under the cuddy-board or under the box. In Fayal, on the first Sunday in

August, there is held each year the whalemen's own festival, the *Festa dos baleieros*, when the whaleboats are blessed (Plate XVIII). On this day the boats from Capelo and Salão come down in strength to Porto Pim, where they are beached in line upon the sandy shore to the isthmus which leads to Monte da Guia. The crews wear their best clothes of black serge, and each boat is dressed with flags; the line-tubs are uncovered and the line taken to the loggerhead, and the first and second irons and a lance are set ready at the prow. The dedicatory service takes place on the high top of Monte da Guia, in the little church whose vestry is a whale look-out. For the rest of the year no other service is celebrated there. After the service, the image of the Virgin and Child is borne from the church down the long winding road to the isthmus. The whalemen of the Porto Pim factory have earlier strewn flowers and set up arches of green boughs to make the road into a processional way, and there are a brass band and rockets and fire crackers. Arrived at the beach, the priest visits each boat in turn. The bearers rest the image athwartships, forward of the loggerhead, and looking out to sea. From the after-tub the harponeer takes a bight of line and doubles it, to make a length which he passes round the saint and loosely ties, whilst the line remains snubbed at the loggerhead. When the blessing is over, the image is carried to the next boat. In this symbolic way the Sperm whalemen make once a year a holy capture and ask a blessing on themselves, that they may catch whales yet be protected from the hazards of the chase.

WHALING IN MADEIRA

Madeira lies some 500 miles south-east of the Eastern Azores and at about two-thirds of the distance between that group and the Canary Islands (Fig. 1). In the days of the whaleships a certain amount of Sperm whaling was carried on in summer around Madeira and was mostly to the north of the island, according to the charts of whaleship catches published by Townsend (1935). But I have heard of no shore whaling business there until 1941 when the increased demand for sperm oil and the restriction of southern whaling combined to bring the Azores industry a new prosperity and gave the incentive for extending the open boat venture to Madeira. One might suppose that any shore whaling anywhere starting anew in modern times would inevitably employ steam whaling methods. But Madeira could replicate the Azores in the coast-frequenting Sperm whales, in the high cliffs suitable for look-outs, and in her island stock of hardy fisherman and boatmen. Here was everything needful to an open boat industry, which, in time of warfare and scarcity, could dispense with the special personnel of modern whaling and could be started economically at a fraction of the capital outlay required for steam whale-catchers and factory plant.

In Madeira as in the Azores the whaleboats take only Sperm whales. Table 9 gives the statistics of the industry for 1941 to 1949. The catch of whales per whaleboat is substantially more than the catch per whaleboat calculated from Table 10 for the same period, around most islands in the Azores, but this may be because weather conditions are better at Madeira rather than because whales are more plentiful there.

Whaling in the island is virtually a replica of the parent methods employed in the Azores, and I imagine that in 1941 Azores whalemen were sent to train the Madeirans in their adventurous trade. Prior to this time the Madeirans themselves had a meagre whaling tradition, for they seem not to be mentioned in the old voyages, and there is only a single record by Clark (1887, p. 56) noting that the Azorean whaling settlement of Cojo Viejo, California, included two or three Madeirans.

I have not myself visited Madeira and I am mostly indebted for the following brief notes to Figueiredo's monograph (1946, pp. 89 and 141 ff.) and to Senhor Tomas Alberto de Azevedo of Fayal who undertook a whaling mission to Madeira a few years ago. There may be recent changes of which I am not aware.

In 1946 there were three look-outs stationed on the cliffs, at Garajau and Ponta do Sol on the south coast, respectively east and west of Funchal, and at Ponta do Pargo at the western extremity. Radio telephone communication between look-outs and motor-launches was introduced in San Miguel and in Madeira at about the same time. There are three whaleboat stations, at Funchal and Câmara de Lobos in the south and at São Vincente in the north. They employed in all four motor-launches in 1948 and (according to the *Estatistica das Pescas*) twelve whaleboats. Whales are cut in at Porto Moniz in the north-west and at Garajau in the south. At Porto Moniz a try-works is still used to extract the oil, but at Garajau (where there is a flensing platform) the method of extraction represents the stage

Table 9. *Statistics of open boat whaling for Sperm whales in Madeira from* 1941 *to* 1949

Year	Catch of Sperm whales	No. of whaleboats	Whales per whaleboat
1941	76	4	19·0
1942	23	7	3·3
1943	133	13	10·2
1944	75	13	5·8
1945	91	14	6·5
1946	166	14	11·9
1947	109	13	8·4
1948	162	12	13·5
1949	135	12	11·3
1941–49	970	102	9·5

reached by modern overseas whaling between 1904 and 1925. As much as possible of the animal is saved. There is a pressure-cooker which deals with entrails, meat, and bone: but the blubber and head matter are cooked in open vessels with boiling water. This method of 'open cooking' of blubber with water yields the finest sperm or whale oil obtainable, with the lowest fatty acid content. Such oil is superior in quality to that from tried out (melted) blubber or from 'apparatus cooked' blubber, although open cooking was superseded in the modern industry about 1925 when pelagic whaling from floating factories began and the various modifications of pressure-cooking, called apparatus cooking, were generally adopted. (Heyerdahl, 1938, p. 346.)

Twenty-six miles north-east of Madeira lies the island of Porto Santo where three whaleboats and a motor-launch have been maintained for several years. Porto Santo, however, has only once appeared in the figures of the *Estatistica das Pescas*, in 1945, but no catch was recorded. Senhor Tomas Alberto de Azevedo told me in 1949 that not a single whale had ever been taken from that island.

SUMMARY

1. Open boat whaling for Sperm whales, conducted with nineteenth-century gear and methods, still survives in the Azores and Madeira. This report describes the history and existing practice of the industry in the Azores, and adds a note on Madeira. The writer visited the Azores in 1949, took part in the whale hunting, and examined sixteen of the twenty-one whaling stations.

2. The *historical section* describes first the course of pelagic whaling, mostly American, on the Azores or Western Islands ground between 1765 and 1921, and then the development of the island shore whaling industry which arose from the experience of the Azoreans in American whaleships.

In the nineteenth century both southseamen and short-cruising plumpuddingers whaled round the Azores and called there (chiefly at Horta, Fayal) for recruits and provisions. The islanders, skilled from childhood in boatwork, made excellent whalemen. For a long period after 1780 Portugal employed some of these skilled nationals in unsuccessful efforts to establish a pelagic whale fishery.

Azoreans were also employed in various shore stations overseas. Afloat and ashore the islanders were ubiquitous in the nineteenth-century whaling scene.

Organized shore whaling in the Azores probably began in Fayal in 1832, but it was not successfully established until the 1850's. Thereafter it spread to the other islands. By the 1920's motor tow-boats were in general use for towing whaleboats and captured whales. At this time a guild of whaling owners was formed, the Grémio dos Armadores da Pesca da Baleia. In 1934 the first steam-powered factory was opened in San Miguel for processing whales, and after the Second World War three further modern stations were built in Fayal, Pico and Flores. These utilize blubber, meat and bone, but at all the other Azores stations only the blubber is saved. It is still removed by 'cutting in', and the oil extracted by 'trying out', using implements and installations of the old New England design, and scarcely changed from seventeenth-century whaling. The latest technical adjunct in the Azores is radio-telephone communication between cliff look-outs and motor tow-boats.

3. The *technical section* notes the uniqueness of the present survival of open boat whaling in the Azores and Madeira; and then describes exhaustively the boats, gear and methods of the survival, compares them throughout with those of American nineteenth-century whaling, and attempts to explain the very few differences.

The present whaleboats are seven-man boats and are longer than the American boats which carried six men. Boat furnishings and gear have not changed; and nor has the technique of hunting except that in the Azores the harponeer both fastens and lances the whale, and does not change places with the boatheader for lancing.

At try-works stations the whale is cut in either stranded on the beach or floating alongside a jetty. The method of cutting in alongside is the old whaleship practice brought ashore. Trying out, and the various try-works stations, are described.

The report describes working up at Azores modern stations because this has evolved independently of Norwegian practice and shows interesting differences.

Minor products of the Sperm whale are discussed. The intestines are always searched for ambergris which is occasionally found. Scrimshaw, learned from the whaleship days, is practised as a cottage industry. In Pico the blackskin of the whale is sometimes tanned into durable shoe-leather. Tendons and connective tissue fibres are widely used for whips or lashings.

The life of the Azores whalemen has scarcely changed in 100 years. The whalemen are devout Catholics and once a year there is a *festa dos baleieros* when the whaleboats are blessed.

4. In *Madeira* Sperm whaling did not start until 1941. It is the same whaling as in the Azores whence it presumably came. There were in 1946 three whaleboat stations and two factories, one a try-works station and one a steam-powered plant.

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Table 10. *Statistics of open boat whaling for Sperm whales in the Azores from 1896 to 1949*

Year	Catch of Sperm whales: Santa Maria	S. Miguel	Terceira	San Jorge	Graciosa	Faial	Pico	Flores	Corvo	Azores
1896	[illegible]	6	6		2	5	13	2		37
1897	1	8	2		4	9	28	2		54
1898	3	13	4	4	6	2	20	2		54
1899	3	13	2	9	5	8	36	1		79
1900		25	3	1	1	1	46	[illegible]	1	83
1901	3	9	2	3	1	1	27	1		49
1902	2	32	1		3		[illegible]	4		122
1903	[illegible]	34	4	5	4		46			99
1904		19	2	9	6		54	1		91
1905		9	6	5	4	2	7			33
1906		7	2	4	3	1	97			117
1907		2	2	7	6	3	66			124
1908		24	5		6	15	83	1		136
1909		2	9	1	2	4	44			[illegible]
1910		[illegible]		13	5	13	68	2		112
1911		[illegible]	2	12	7	15	74			[illegible]
1912		1		13	4	9	36			72
1913		1	3	14	11	5	25			68
1914			1	4	7	3	22			35
1915		7		1	2	1	22			
1916		9		1	9	3	47			71
1917		19	1	12	9	25	62			[illegible]
1918		8	2	20	2	24	117	1		[illegible]
1919		16		33	5	18	55	[illegible]		[illegible]
1920		5		11	6	17	55			[illegible]
1921			3	7	1	9	37	1		[illegible]
1922		11				47	64			121
1923		17	5	25		30	79	2		[illegible]
1924		11				15	41	1		71
1925		22		[illegible]	4	30	64	4		151
1926		7		32		15	137	8		199
1927		3		29	7	32	88	7		166
1928		19		26	2	15	115	8		185
1929		7		73	5	17	111	9		212
1930		12		74	2	1	36	14		99
1931				17	6		[illegible]	4		86
1932		7		72	8	2	115	14		179
1933		64		24	15	12	145	8		266
1934		74		73	2	4	132	9		234
1935		38		21	10		272	18		379
1936		88		22	1	6	[illegible]	13		357
1937		[illegible]		20		10	224	47		417
1938	22	66		25		39	[illegible]			417
1939	37	107		[illegible]	7	41	118	55		[illegible]
1940	22	65	7	52	3	102	[illegible]	45		552
1941	29	39	23	[illegible]	4	[illegible]	239			341
1942	[illegible]	61	35	31	3	53	[illegible]	32		525
1943	18	[illegible]	36	6	6	[illegible]	207	[illegible]		663
1944	36	152	12	43	3	[illegible]	217	74		591
1945	[illegible]	112	[illegible]	26	9	[illegible]	[illegible]	28		447
1946	[illegible]	117	54	43	17	79	[illegible]	34		592
1947	29	146	25	19	9	115	144	75		[illegible]
1948	[illegible]	121	32	48	27	97	251	52		698
1949	57	87	26	26	25	56	120	57		454
Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Year	No. of whaleboats: Santa Maria	S. Miguel	Terceira	San Jorge	Graciosa	Faial	Pico	Flores	Corvo	Azores
1896	2	4	6	4	1	16	5	13	9	63
1897	2	2	4	4	4	13	34	13	9	83
1898	2	4	4	3	4	6	34	13	9	79
1899	2	4	4	11	5	14	44	3		87
1900	2	8	4	2	4	2	47	16	8	93
1901	2	8	4	7	3	3	50	3	9	87
1902	2	[illegible]	2	4	4	16	46	17	11	[illegible]
1903	2	9	4	4	4	3	46	17		97
1904	2	4	5	8	6		34	12	6	77
1905		4	3	12	6	14	14			31
1906		4	8	8	6	2	26			71
1907		4	4	8	6	5	43			72
1908		4	4		5	7	4	[illegible]		69
1909		1	4	4		12	4			[illegible]
1910		2		6	4	8	43	6		71
1911		2	4	6	[illegible]	12	32			79
1912		3				14	53			81
1913		4	4	7	4	[illegible]	32			36
1914			2	4	4	11	21			42
1915		[illegible]		4	5	4	4			57
1916				4		4	42			76
1917			2	8	3	5	47			66
1918			2	6	[illegible]	8	[illegible]			75
1919		1		8	3	7	44	3		71
1920		4		7	3	11	47			72
1921			3	7	3	6	43	8		65
1922		4				9	43	[illegible]		59
1923			3	7		15	43	4		75
1924		[illegible]				14	42	5		62
1925				8	3	10	35	6		74
1926		7		6		1	33	7		[illegible]
1927				6	3	9	35	[illegible]		59
1928				6	3	4	[illegible]	[illegible]		51
1929		6		6	3	3	35	[illegible]		56
1930		4		6	3	[illegible]	[illegible]	6		[illegible]
1931				6	3		21	3		33
1932		4		5	3	[illegible]	[illegible]	6		48
1933		6		5	[illegible]	[illegible]	32	6		58
1934		6		4	[illegible]	[illegible]	34	7		57
1935		12		6			31	7		50
1936		12		7		[illegible]	31	7		62
1937	2	9		8	3	3	36	7		68
1938	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
1939	[illegible]	5		7		7	[illegible]	[illegible]		63
1940	3	[illegible]	2	7	3	9	[illegible]	10		77
1941	2	5	4		3	[illegible]	41			155
1942	2	12	6	1	[illegible]	11	41	9		92
1943	2	11	6	1	3	11	46	1		99
1944	3	12	6	12	3	1	44	9		97
1945	3	[illegible]	5	7	3	13	[illegible]	12		96
1946	3	13	5	7	6	[illegible]	42	17		123
1947	4	15	[illegible]	7	4	12	43	18		128
1948	4	17	[illegible]	7	11	12	51	18		125
1949	4	15	7	5	12	12	56	18		125
Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Year	Whales per whaleboat: Santa Maria	S. Miguel	Terceira	San Jorge	Graciosa	Faial	Pico	Flores	Corvo	Azores
1896	1.5	[illegible]	[illegible]		[illegible]		[illegible]	2		[illegible]
1897	.5	4			[illegible]	7	[illegible]	2		[illegible]
1898	1.5	[illegible]			1.5		[illegible]	[illegible]		[illegible]
1899	[illegible]	3	.5		[illegible]	[illegible]	[illegible]	[illegible]		.9
1900	1.5	[illegible]	.7			[illegible]	[illegible]	[illegible]		.9
1901	1.5	[illegible]	.5	[illegible]			[illegible]			.6
1902	1	4	.5		[illegible]		[illegible]	2		[illegible]
1903	1.5	[illegible]	[illegible]		[illegible]		[illegible]			1.4
1904	1.5	4	.4	[illegible]	[illegible]		1.6	1		1.4
1905		2	[illegible]	.5	[illegible]	[illegible]	[illegible]			.6
1906		2	.4		[illegible]	[illegible]	[illegible]			[illegible]
1907		[illegible]	[illegible]	.9	1	[illegible]	1.5			1.7
1908		6	[illegible]			2.1	2.1	[illegible]		[illegible]
1909		[illegible]	[illegible]	1.3		[illegible]	1.1			.4
1910		[illegible]		[illegible]		1.6	1.5	[illegible]		[illegible]
1911		[illegible]	.5	[illegible]	1.7	1.3	1.4			[illegible]
1912		[illegible]		1.6	1.3	[illegible]	[illegible]			[illegible]
1913		[illegible]	.5	[illegible]	[illegible]	1	.8			[illegible]
1914			.5	[illegible]	[illegible]	.3	1.2			
1915		[illegible]			.7	.3	[illegible]			.6
1916				[illegible]	[illegible]	[illegible]	1.2			[illegible]
1917		[illegible]	.5	[illegible]		.5	1.4			[illegible]
1918		[illegible]	.1	[illegible]		.3	[illegible]	[illegible]		2.4
1919		[illegible]		[illegible]	1.7	[illegible]	1.3	[illegible]		1.9
1920		1.3		1.6	[illegible]	1.6	1.8			1.7
1921			[illegible]	[illegible]	[illegible]	1.5	1.3	[illegible]		1.2
1922		2.8				4.8	1.5	1		[illegible]
1923		5.7	[illegible]	3.6		2.4	2.1	[illegible]		2.4
1924		3.7				1.3	1.0	[illegible]		1.1
1925		6.7		2.5	[illegible]	2.4	1.7	[illegible]		2
1926		[illegible]		5.3		1.5	4.1	1.3		3.4
1927		1		4.8	[illegible]	3.6	2.5	2.3		[illegible]
1928		[illegible]		[illegible]		3.8	3.6	2.7		[illegible]
1929		[illegible]		5.5	2.7	5.7	3.1	[illegible]		[illegible]
1930		[illegible]		3.7	[illegible]	.5	.9	2.3		[illegible]
1931				[illegible]	2		[illegible]	1.3		[illegible]
1932		2.0		6.4	2.7	1.2	[illegible]	2.3		[illegible]
1933		10.7		4.8	5	3.3	[illegible]	1.3		[illegible]
1934		9.0		8.3	[illegible]	[illegible]	3.8	1.3		[illegible]
1935		4.8		3.5			[illegible]	2.6		[illegible]
1936		7.1		3.1		[illegible]	[illegible]	1.9		[illegible]
1937	4	11.3		[illegible]		[illegible]	[illegible]	6.7		6.1
1938										
1939	12.3	21.4		[illegible]		1	3.9	[illegible]		[illegible]
1940	[illegible]	8.1	1	[illegible]	1	[illegible]	7.4	4.5		[illegible]
1941	14.5	4.9	[illegible]		1		5.8	[illegible]		[illegible]
1942	11.5	6.1	[illegible]	1	1	[illegible]	7	3.5		[illegible]
1943	[illegible]	8.1	6		[illegible]	[illegible]	6.3	[illegible]		[illegible]
1944	[illegible]	12.7	2	[illegible]	[illegible]	[illegible]	4.9	8.2		[illegible]
1945	[illegible]	5.5	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		4
1946	[illegible]	9	[illegible]	6.1	[illegible]	7.9	[illegible]	[illegible]		[illegible]
1947	7.3	9.7	5	[illegible]	[illegible]	[illegible]	3.3	4.3		[illegible]
1948	7.5	7.1	[illegible]	6.9	[illegible]	8.1	4.9	[illegible]		[illegible]
1949	14.2	5.8	3.2	3.2	5	7.2	2.1	3.2		
Average	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]		

In the calculation of the average value, for each year and for each island, of the ratio 'whales per whaleboat' I have disregarded instances where numbers of whaleboats are recorded but nil catch of whales, or vice-versa. [illegible] 1896 to 1924 [illegible] 1938)

PLATE XIII

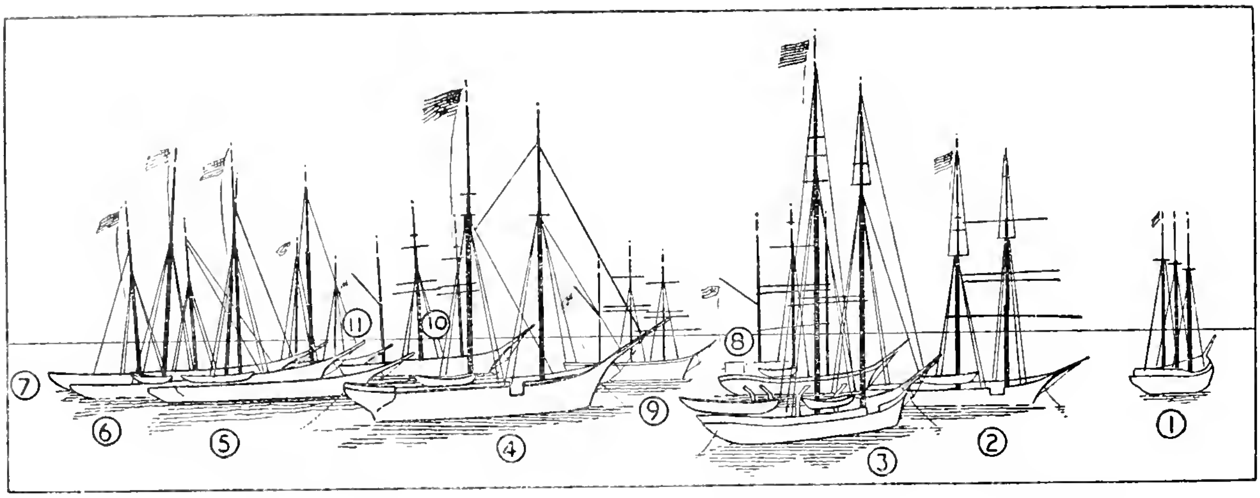


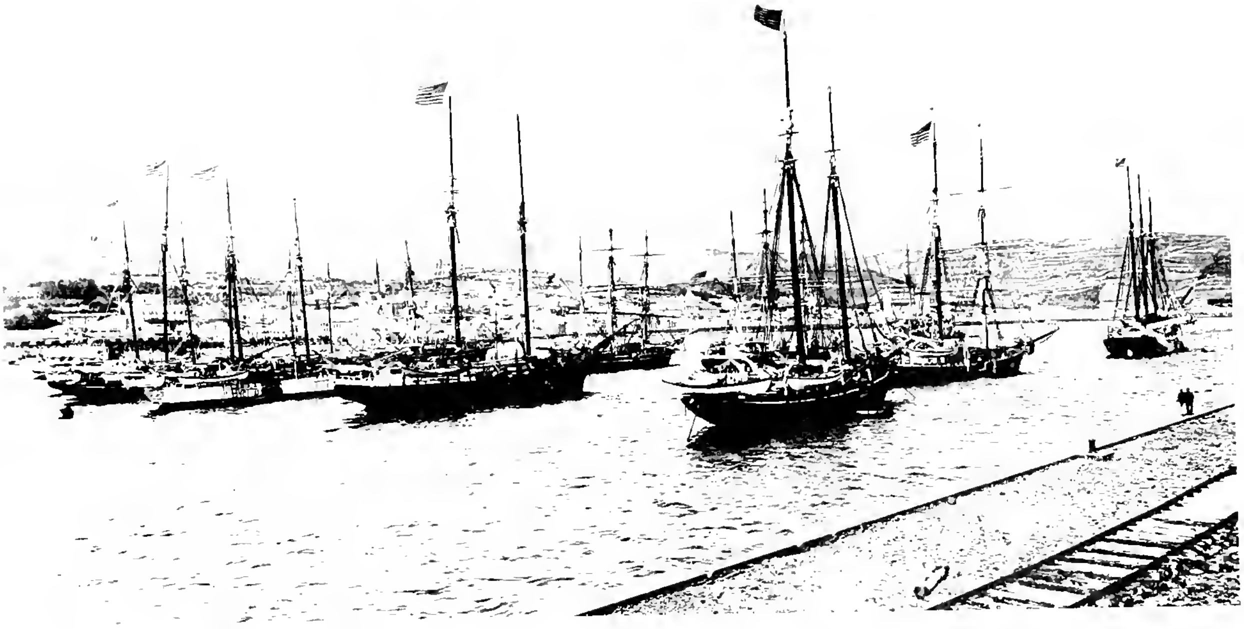
Fig. 1. Whaleships at Horta, Fayal, in September 1910. (*Photo:* Senhor Goulart, Horta.)

KEY TO OUTLINE SKETCH ABOVE

1. *Richard W. Clark*
2. *Viola*
3. *Bertha D. Nickerson*
4. *Cameo*
5. *Pedro Varela*
6. *Carleton Bell*
7. *T. Towner*
8. *Bertha*
9. *Morning Star*
10. *Wanderer*
11. *John R. Manta*

These vessels appear in Table 2, pp. 290–1.

Fig. 2. Whaleboats on the launching slip at Salão, Fayal. 12 August 1949.



1

2

PLATE XIV

Fig. 1. Model of an Azores whaleboat made by a whaleboat builder of Pico in 1949.

Fig. 2. Plan view of the model whaleboat and its gear.

Above the boat

steering oar	lances with sheaths
pulling oars	harpoons with sheaths.

The boat

(some furnishings from stem to stern; see also Pl. XIII, fig. 2)

steering-oar brace			boat hatchet
after boat-knife	standing-cleats	mast-hinge	thigh-board *with*
loggerhead *and*			forward boat-knife
lion's tongue			chocks.

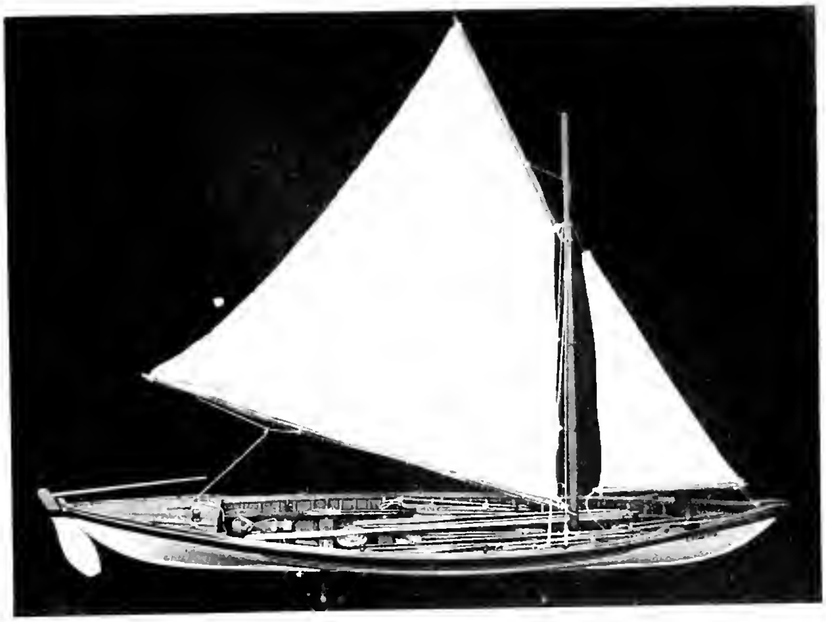
Below the boat

	piggin	tiller		
lantern box	boat-bucket	rudder	paddles	line-tubs
	boat-keg	waifs (3)		

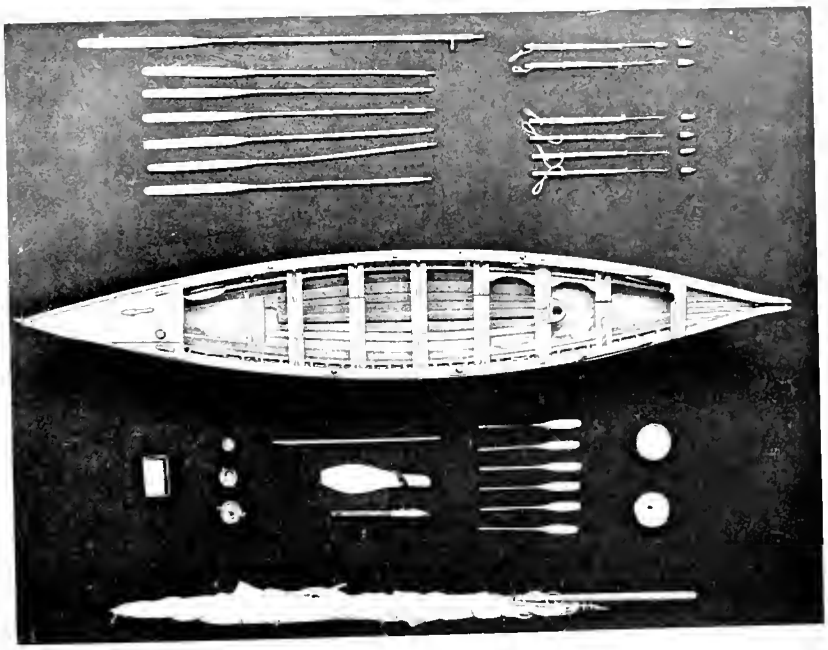
mast, mainsail boom, and sails.

Fig. 3. Cliff look-out above Porto do Castelo, Santa Maria. 23 June 1949.

Fig. 4. Interior of the Porto do Castelo look-out.



1



2

3

4

PLATE XV

Stills from the cine-film made off Capelo, Fayal, on 11 and 13 August 1949

Fig. 1. Whaleboat under oars preparing to chase.

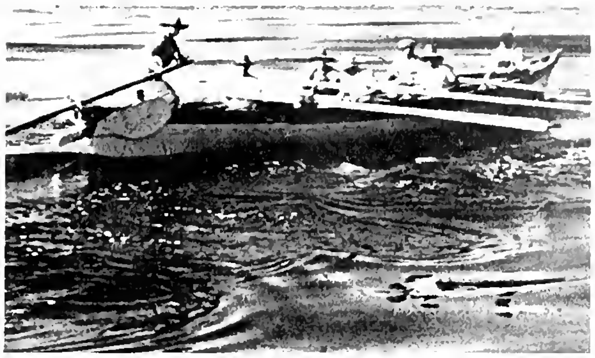
Fig. 2. Whaleboat under sail, chasing.

Fig. 3. Chasing. A whale peaks his flukes and sounds.

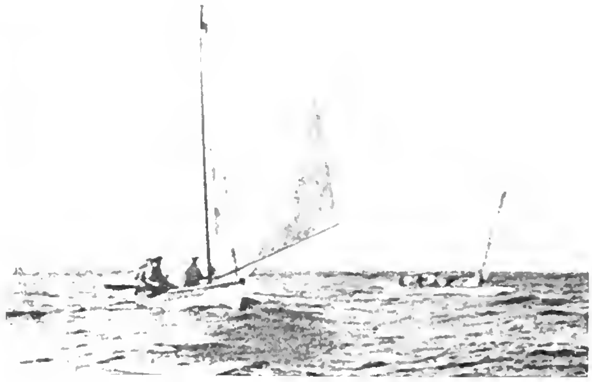
Fig. 4. Going on a whale. Photographed a moment before the harpooneer put aside his paddle and stood up for the dart.

Fig. 5. The dart. Fastening a 53-foot bull.

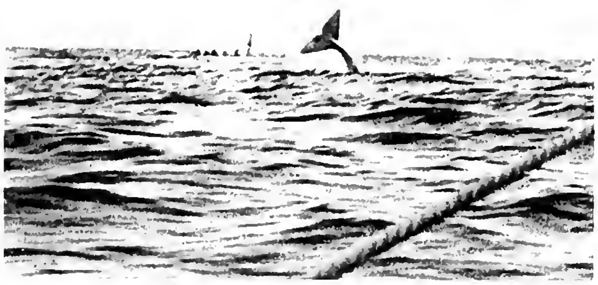
Fig. 6. The flurry.



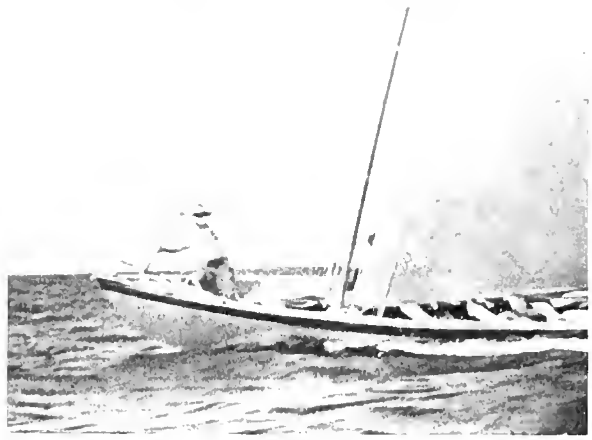
1



2



3



4

5

6

PLATE XVI

Fig. 1. Try-works station of Porto do Castelo, Santa Maria, 23 June 1949. Whales are cut in on the beach at the head of the inlet between the reefs. The try-house can be seen built against the foot of the cliff.

Fig. 2. Stranding slip with try-works at Lagens do Pico, 24 August 1949. Note the crab on the right with a stone blubber tank to the left of it.

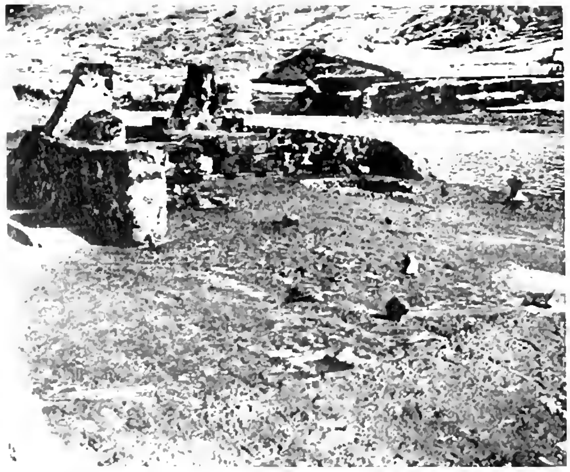
Fig. 3. Quay for cutting in alongside at San Mateus, Pico, 24 August 1949. Note the samson's-posts for cutting tackles.

Fig. 4. The modern station on the cliff at Santa Cruz das Flores, 1 July 1949. Note the slipway between stone walls, and the level flensing platform above it.

Fig. 5. Heaving up a 53-foot (16 m.) whale at the modern station at Porto Pim, Fayal, 12 July 1949. The head has hollow-lines in front of the eye (p. 329). Note also the cut-water or nib end in front of the anterior margin of the palate (p. 323).

Fig. 6. The flensing platform at Porto Pim, 16 August 1949.

1



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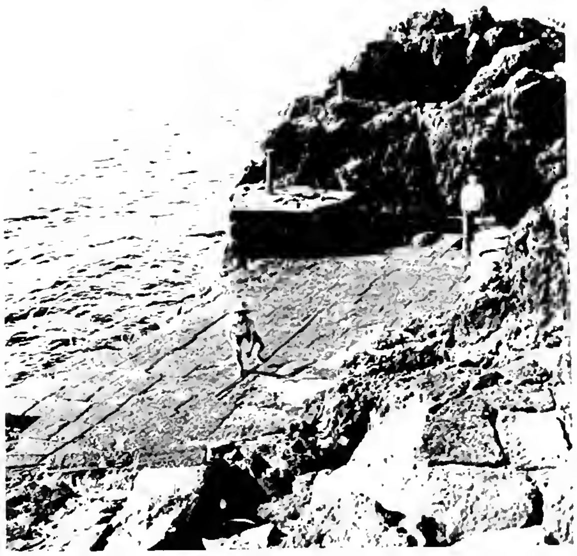

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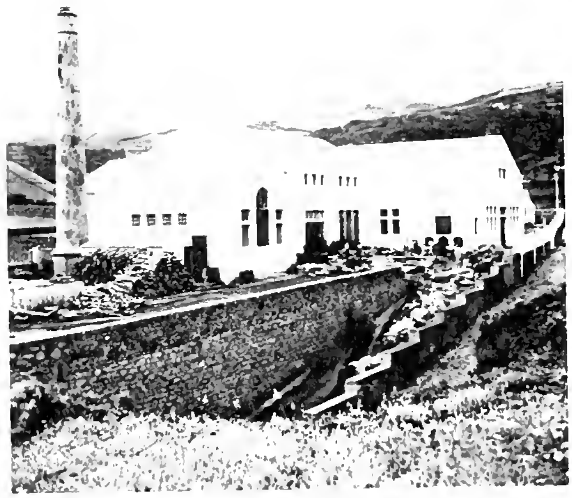

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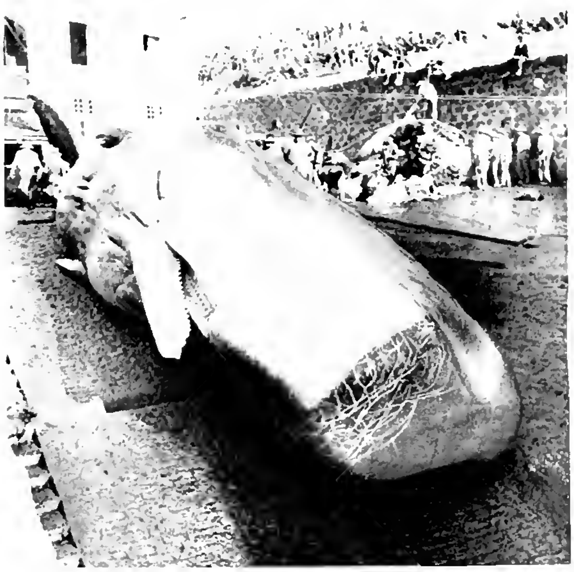

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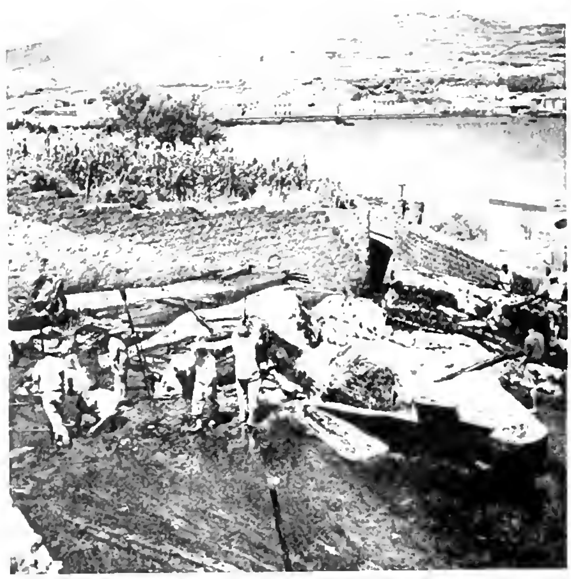

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PLATE XVII

Fig. 1. Working up at Porto Pim. Flensing the blubber piecemeal with cutting spade and hook. 14 August 1949.

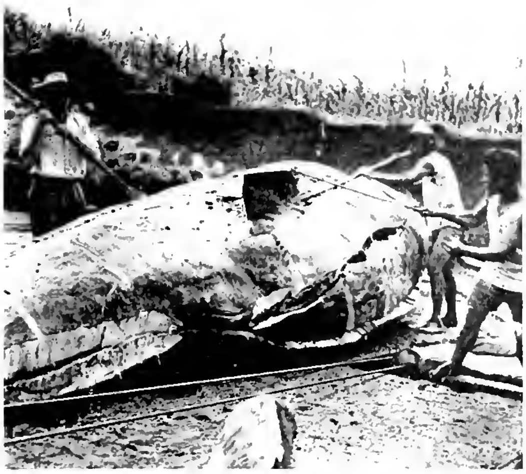
Fig. 2. Working up at Porto Pim. The two 'merlons' of blubber left for canting the whale (p. 344). Holes have not yet been mortised into the merlons. 16 August 1949.

Fig. 3. Working up at Porto Pim. Disarticulating the lower jaw from the head. 16 August 1949.

Fig. 4. The blubber staircase on the platform of the modern factory at São Vincent, San Miguel. 27 June 1949.

Fig. 5. Manual press for removing sperm oil from spermaceti in the factory at São Vincent. The four blubber tubs contain spermaceti. 25 June 1949.

Fig. 6. Manual press used in the manufacture of meat meal at São Vincent. 25 June 1949.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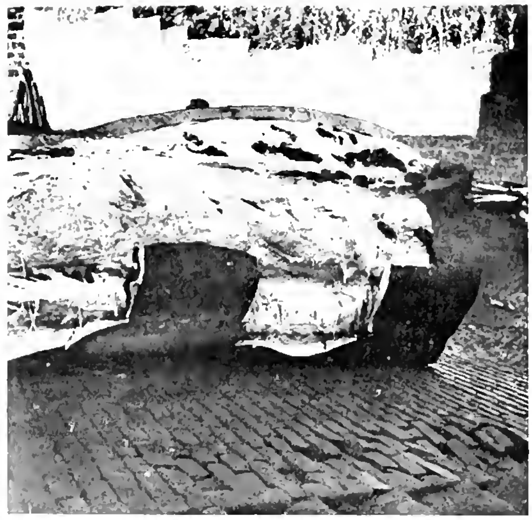
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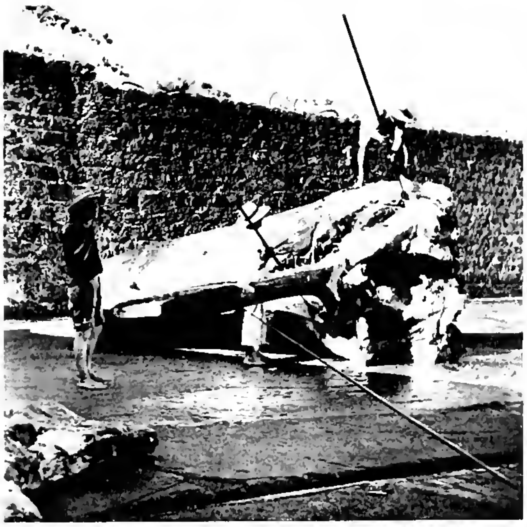
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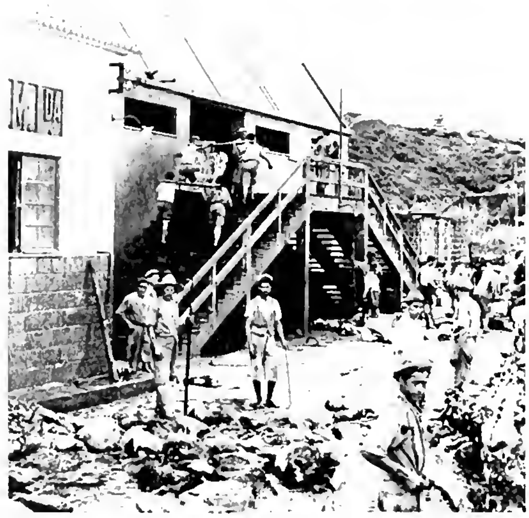

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PLATE XVIII

Fig. 1. Spare try-pot with whalecraft in the try-house at Porto do Castelo, Santa Maria. 23 June 1949. The whalecraft from left to right are: blubber fork; two scarfing spades; leaning spade; bone spade; leaning spade; boat spade and blubber pike. A boiler lies across the pot; an (unmounted) scrap dipper lies at the foot of the pot on the left.

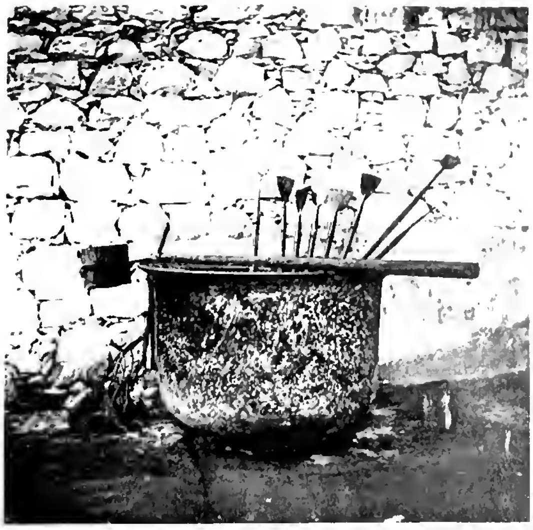
Fig. 2. Try-works at Lagens do Pico. 24 August 1949. Open try-works with two pots. Note the main cooler with second and third coolers behind it.

Fig. 3. Corner of the try-house at Porto do Castelo, Santa Maria. 23 June 1949. Blubber tubs and mincing tubs beside a heap of scraps.

Fig. 4. Scrimshaw tooth of the nineteenth century believed to have been engraved by a Portuguese whaleman (p. 348).

Fig. 5. *Festa dos baleieros* at Porto Pim, Horta, Fayal, on Sunday, 7 August 1949. Blessing a whaleboat: the whaleline is knotted round the Saint.

Fig. 6. *Festa dos baleieros*. Beflagged whaleboats each dressed with harpoons and lance.



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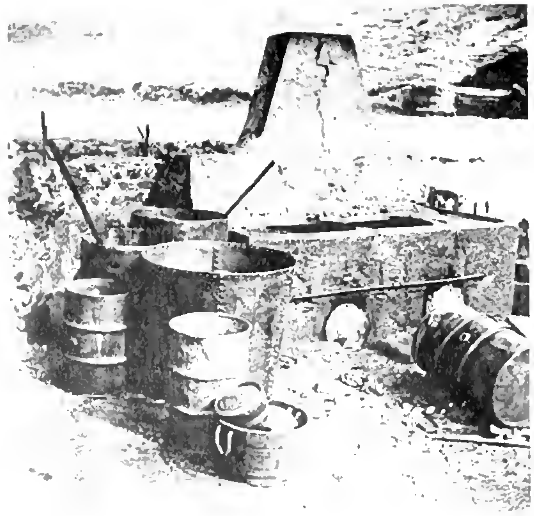

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[*Discovery Reports. Vol. XXVI, pp. 355–384, January 1954.*]

DISPERSAL IN BLUE AND FIN WHALES

By

S. G. BROWN

CONTENTS

DISPERSAL IN BLUE AND FIN WHALES

By S. G. Brown
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(Text-figs. 1–14)

INTRODUCTION

In an investigation of a population of almost any mobile animal a matter of obvious importance is the range of movement of the individuals within the area which the whole population inhabits, and this is also of practical significance when the animals are economically valuable. In the southern summer baleen whales are distributed over several million square miles in the Southern Ocean, and in the winter they generally migrate into warmer waters. One of the many objects of marking whales is to gain information on the time, direction and range of these seasonal migrations, which tend to run in a north and south direction; but it is also necessary to examine movements in other directions, and to consider whether different parts of the Antarctic may be inhabited by the same whales year after year, whether there are segregated communities of whales, or whether there is much or little interchange of individuals by lateral dispersal.

In a programme of whale-marking under the Discovery Committee, over 5000 whales were marked in the Antarctic between 1932 and 1939. By the end of the latter year 203 marks had been returned from 187 whales, and at this stage an analysis of the results was published by Rayner (1940). His report gave particulars of the method of marking and a statement of the data available. He plotted all the positions of marking and recovery on a series of charts, demonstrated some of the migration routes of Humpbacks, and pointed out among other things that Blue, Fin and Humpback whales generally returned year after year to the same part of the Antarctic as that in which they were marked. He emphasized, however, that there were exceptions to this tendency among Blue and Fin whales, some of which were found to have moved for varying distances to the east or west, either within a few weeks or months, or after one or more years. Although full details of these movements were shown on his charts he did not at that stage make a quantitative analysis of them.

Hardly any marking has been done in the Antarctic since 1939. In 1950 some whales were marked in South African waters, but these were mainly Sperm whales. However, since Rayner's report was written a further 104 of the pre-war marks have been recovered in the Antarctic from twelve Blue and ninety Fin whales. Two more have been recovered from Humpbacks in Australian waters. This new material does not add much to the statistical value of the data available to Rayner, and a full analysis is probably best postponed until more marks have been recovered. However, these later recoveries extend over a much longer period than those previously described—up to thirteen years from Blue and seventeen years from Fin whales. It is useful therefore to list the total recoveries to date, and to see what new information can be extracted. The present paper can be regarded as an interim report, mainly concerned with dispersal in time, which is examined on a quantitative basis.

A full list of marks returned from Blue and Fin whales, with sex and length when available, is given in the Appendix, Tables 6 and 7, pp. 378–84.

This work was undertaken at the suggestion of Dr N. A. Mackintosh who has given me some general guidance on the treatment of the subject. I have also to thank Mr J. Crease, of the National

Institute of Oceanography, who gave me most useful advice on certain statistical points, and I am grateful to Mr J. A. Gulland, of the Fisheries Laboratory, Lowestoft, who kindly read through the typescript of the paper and made several helpful comments.

MARKING IN THE ANTARCTIC AREAS

Hjort, Lie & Ruud (1932–38), Bergersen, Lie & Ruud (1939), and Bergersen & Ruud (1941), in a series of papers on 'Pelagic Whaling in the Antarctic' divided the Antarctic whaling grounds south of 50° S into five areas. Area I was a small area around the South Shetland Islands and Areas II–V, from 60° W to 170° W, were based on the distribution of the whaling fleet which the authors showed to form separate concentrations in each area, these being founded on inferred separate concentrations of Blue and Fin whales in each of the four areas. Mackintosh (1942) examined the distribution of Blue, Fin and Humpback whales around the Antarctic continent and came to the conclusion that Humpbacks in the southern hemisphere are divided into several separate communities between which there can be very little exchange. Each of the Areas II–V appears to contain one of these Humpback communities. While Blue and Fin whales are more evenly distributed in the Antarctic than Humpbacks, they have at least a tendency to concentrate in the same areas as the Humpbacks and this is more definite in Blue than in Fin whales. He suggested that the Area I of Hjort, Lie & Ruud might suitably be extended to cover 60° W to 120° W and that a new Area VI from 120° W to 170° W might be created. This proposal was accepted in 1947 by the Whaling Committee of the International Council for the Exploration of the Sea,[1] and in the present paper the boundaries of Area I have been modified accordingly.

These six areas are shown in Fig. 1, which also shows where whale-marking has been carried out. The method of hatching, to show the relative intensity of marking, is taken from Rayner's Plate XLV (1940). The diagonally hatched areas show where marking has been chiefly conducted and where most whales have been marked. There is a comparatively small area of intensive marking around South Georgia, and around the Shag Rocks a smaller area, of 70 miles radius, indicated by denser cross-hatched shading, where more than 600 have been marked. There are two other extensive areas in which relatively large numbers of whales have been marked, one off Queen Mary Land (85–95° E) and a second, much larger, extending westwards from Enderby Land (15–50° E). In addition, whales in smaller numbers have been marked over an immense area connecting and extending these principal regions; on the chart the continuous longitudinal lines show where this marking has been relatively dense, the broken lines where it has been sporadic. This of course gives only a rough impression of the initial distribution of marked whales, but it is probably sufficient for the purposes of the present paper. Fuller details of the positions of marking were published by Rayner in a short second report (1948). Here it should be noted that marking was spread over four of the six areas (i.e. Areas I–IV), that large numbers of whales were marked in Area II near South Georgia (by hired catchers), and especially to the west of the island, and that many whales have been marked also in Areas III and IV. The numbers marked in each area are given in Table 5, p. 374.

DISPERSAL OF WHALES

Rayner's data included marks recovered after periods up to four years, and these suggested that in both Blue and Fin whales the range of dispersal was limited, movements after four years having no greater amplitude than those after one year.

In the present paper, the term 'dispersal' will be used to describe the ultimate movement of whales east or west from the position in which they were marked, and whales which show this move-

[1] See *Rapp. et Proc.-Verb. des Réunions*, 1947, *Cons. Perm. Internat. Explor. Mer*, CXVII, p. 43.

ment will be said to have 'dispersed'. It is naturally important to remember that a whale may have done much travelling between the positions of marking and recovery. For example, if a whale, marked in one summer season and recovered in another, has dispersed say 20° east or west, it has

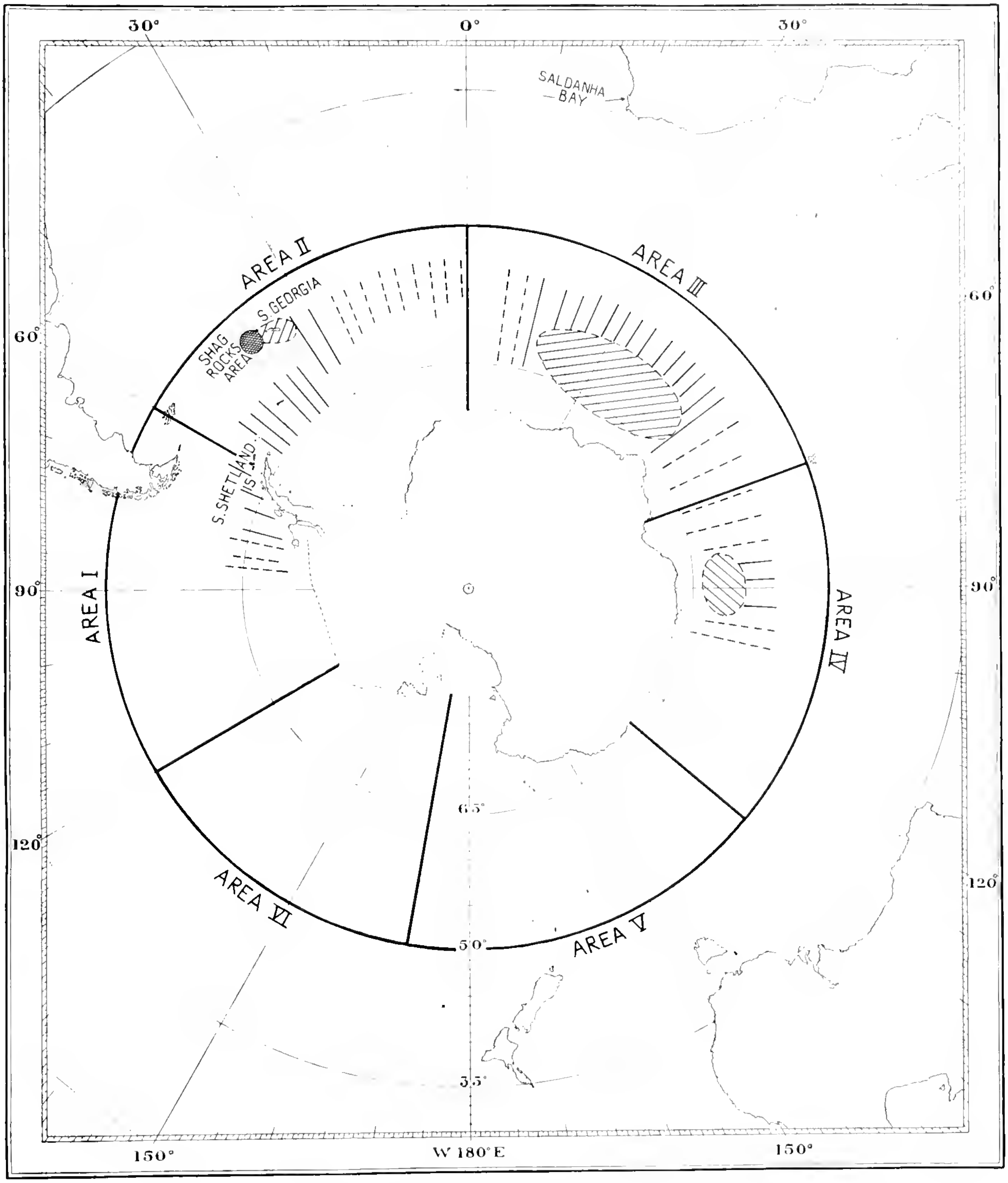

Fig. 1. Chart showing diagrammatically the distribution of marked whales and the boundaries of the Antarctic whaling areas.

probably in the meantime undertaken a long migration, possibly of 2000 miles to the north and back. Even when a mark is recovered after a few weeks the whale may have wandered a long way from the direct line from the position of marking to the position of recovery.

A study of the dispersal of whales involves two factors. First, the proportion of whales showing dispersal and the range or distance to which these whales disperse. Second, the changes in this proportion and range of dispersal over a period of time.

The dates and positions of marking and of capture of the whales from which marks have been recovered are known, and it is possible to construct time-charts which show diagrammatically the dispersal of individual whales by means of lines connecting the position in degrees longitude of marking in one whaling season, and the position of recovery in the same season or in a later one. The lower end of each line is the longitude and date of marking, and the upper end of the line is the longitude and date of recovery. The horizontal axis of the time-chart (Figs. 2, 3, 4 and 12) is divided into degrees of longitude, the positions of the Areas II–IV being indicated. The vertical axis shows the successive whaling seasons. The position in degrees of latitude is not used as this is to a large extent dependent upon the date on which marking and capture took place. Recoveries and marking made later in the whaling season are almost always in a more southerly position than the earlier ones because of the southward movement of whales with the retreating ice during the course of the season. The lines connecting the positions of marking and recovery may be termed 'tracks', though they in no way represent the actual movements of the whales in the period between these two events.

In this method of plotting the data, vertical tracks indicate whales which have either remained in, or more probably returned to, the longitude in which they were marked, although they may have been captured some degrees north or south of the actual position of marking. Tracks at an angle to the vertical indicate whales which have dispersed from the area of marking to a lesser or greater degree. The time-charts also show the differences in behaviour of whales marked in the same area during the same season and recovered in later seasons in widely separated areas, and the movements of whales between Areas I–IV.

The system of year-groups used by Rayner (1940) has been followed in this paper. Marks recovered during the season of marking are referred to as the 0-group, those recovered in the following season after an average lapse of one year as the 1-group, those after two years as the 2-group, and so on.

It will be convenient to discuss dispersal in Fin and Blue whales separately.

DISPERSAL IN FIN WHALES

At the close of the 1951–2 season 218 marks had been returned from 208 Fin whales. For 201 of these whales the position of capture is known. 92 returns have been made since Rayner's analysis. Recoveries have been made in every one of the twenty whaling seasons from 1932–33 (when successful marking was first carried out) to 1951–52, and they cover seventeen year-groups (Table 1). Details of sex are recorded for seventy-five males and sixty-four females, and of length for 139 whales.

Rayner (1940, p. 268 and Pl. LIX) gives details of an important mark (No. 3482) returned from a Fin whale captured off Saldanha Bay, South Africa, about two and a half years after it had been marked in the Antarctic almost directly south of the Cape of Good Hope. A second mark giving evidence of Fin whale migration has now been obtained. Mark No. 9340 was fired into one of three Fin whales on 11 October 1937, in the South Atlantic off the coast of Brazil, in position 28° 03′ S, 46° 17′ W. It was logged when marked as a medium-sized whale, and was captured on 7 January 1949, after a little over eleven years, in position 52° 55′ S, 38° 42′ W, off South Georgia, being recorded as a male Fin whale 73 ft. long. This is the first evidence afforded by marking of the southward migration of Fin whales from sub-tropical waters to the Antarctic.

In view of the number of Fin whale recoveries with sex data, it has been thought worth while to show the tracks of male and female whales separately on two time-charts, and on a third time-chart the tracks of whales for which no record of sex is available. The two marks demonstrating migration

to and from sub-tropical waters have not been included in these time-charts, nor do they appear in any of the other figures.

Table 1. *Marked Fin whales killed in each group*

(See note, p. 377)

Season of marking	Estimated number marked	Returned: Same season 0-group	1st season 1-group	2nd season 2-group	3rd winter $2\frac{1}{2}$-group	3rd season 3-group	4th season 4-group	5th season 5-group	6th season 6-group	7th season 7-group	8th season 8-group
1932–33	202	3	2	—	—	—	2	—	—	—	—
1934–35	778	20	4	5	1	7	3	3	1	—	
1935–36	917	2	2	8	—	6	5			—	
1936–37	1149	5	18	8		1	3	1	1	—	1
1937–38	607	13	9	4	—	6	1	1	1	1	2
1938–39	55	—	—	—	—	—	—			—	—
Totals	3708	43	35	25	1	20	14	5	3	1	3

Season of marking	Estimated number marked	Returned: 9th season 9-group	10th season 10-group	11th season 11-group	12th season 12-group	13th season 13-group	14th season 14-group	15th season 15-group	16th season 16-group	17th season 17-group	Returns to date
1932–33	202	—	—	—	—	1	—	—	—	—	8
1934–35	778	—	1	4	1	2	6	3	—	2	63
1935–36	917	—	—	2	4	1	1	—	4		35
1936–37	1149	3		3	2	3	2	—			51
1937–38	607	4	—	1	2	3	1				49
1938–39	55	1	—	—	1	—					2
Totals	3708	8	1	10	10	10	10	3	4	2	208

In Figs. 2, 3 and 4, the tracks are largely concentrated in Area II, and this reflects the intensive marking near South Georgia. In each of these figures it will be seen that the majority of tracks are more or less vertical, which of course means that most whales return from their migrations year after year to somewhere near the place where they were marked. Several striking examples of such conservatism will be seen in each figure. For example, Mark No. 3204, shown in Fig. 3, was fired into a whale in February 1935, in 63° 28′ S, 26° 54′ E and recovered in March 1952 in 66° 50′ S, 27° 38′ E, i.e. the whale was found after seventeen years less than one degree of longitude away from the position of marking. It must be remembered that the tracks merely show the 'resultant' movement between the dates of marking and recovery, and there is no knowing how the whale may have wandered during this period. However, the rate of dispersal is evidently less in the long-term than in the short-term marks. This phenomenon is further examined below (p. 367). In all three charts comparatively few tracks cross the boundary of an Area.

Fig. 2 shows the tracks of seventy-four male Fin whales. A few have moved between Areas II and III, and three have dispersed eastwards from Area I to Area II. No recoveries of male Fin whales have yet been made in Area IV, but this has no significance since whales of which the sex is not known have been recovered in this area, and some may have been males.

The tracks of sixty-three females are shown in Fig. 3. Five of these whales have moved eastwards from Area I into Area II, and there has been movement between Areas III and IV. There is one

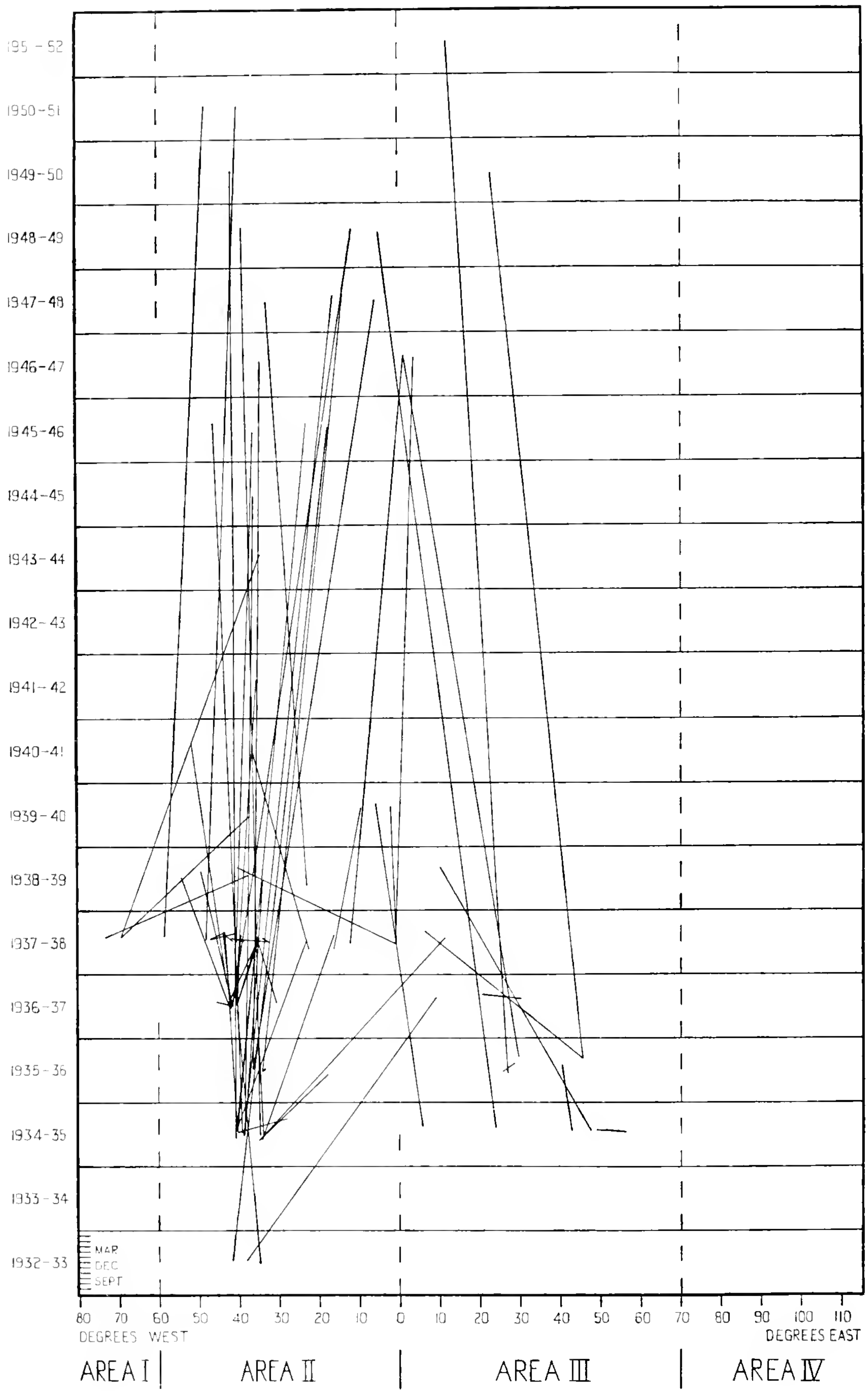

Fig. 2. Time-chart showing dispersal in male Fin whales.

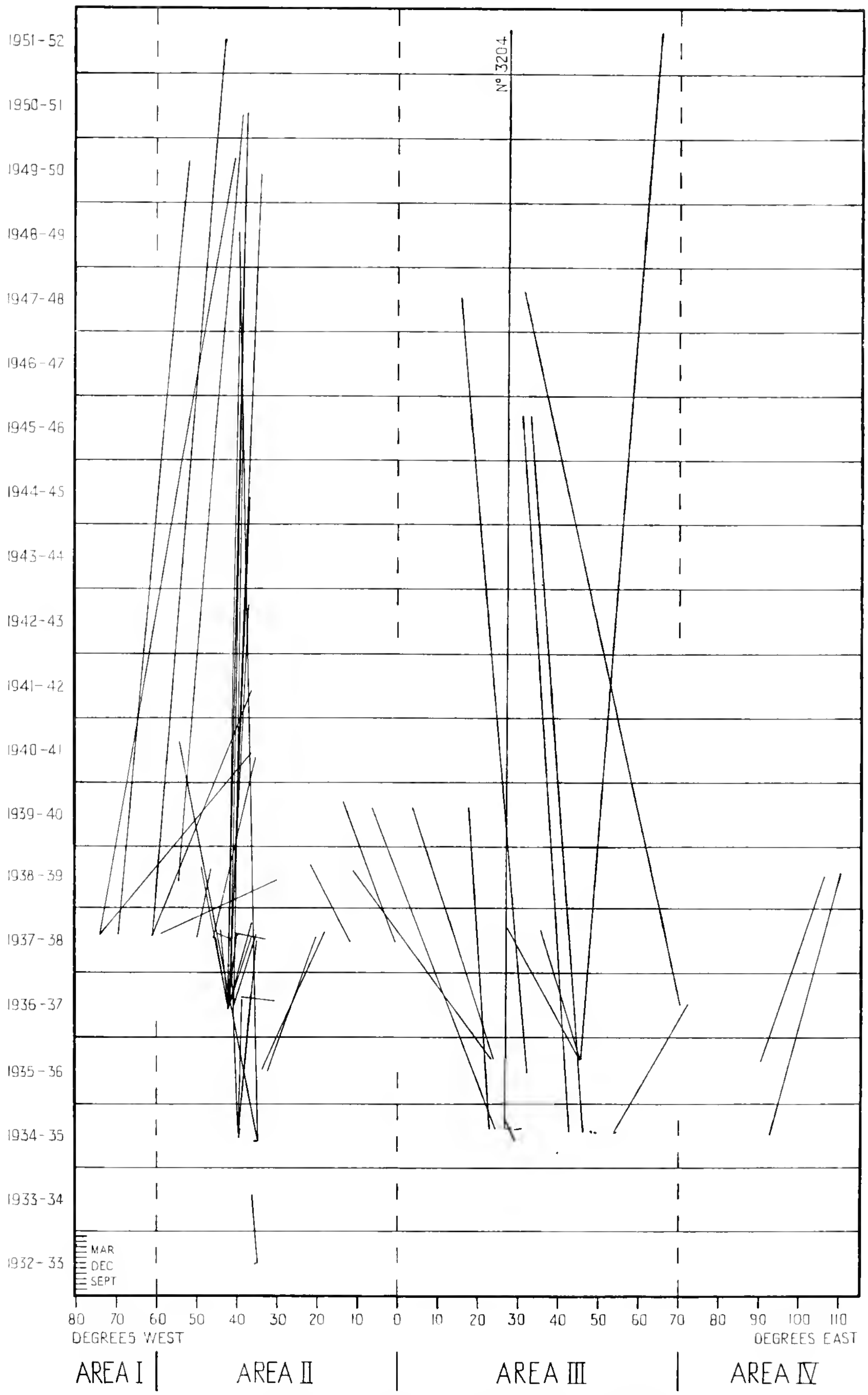

Fig. 3. Time-chart showing dispersal in female Fin whales.

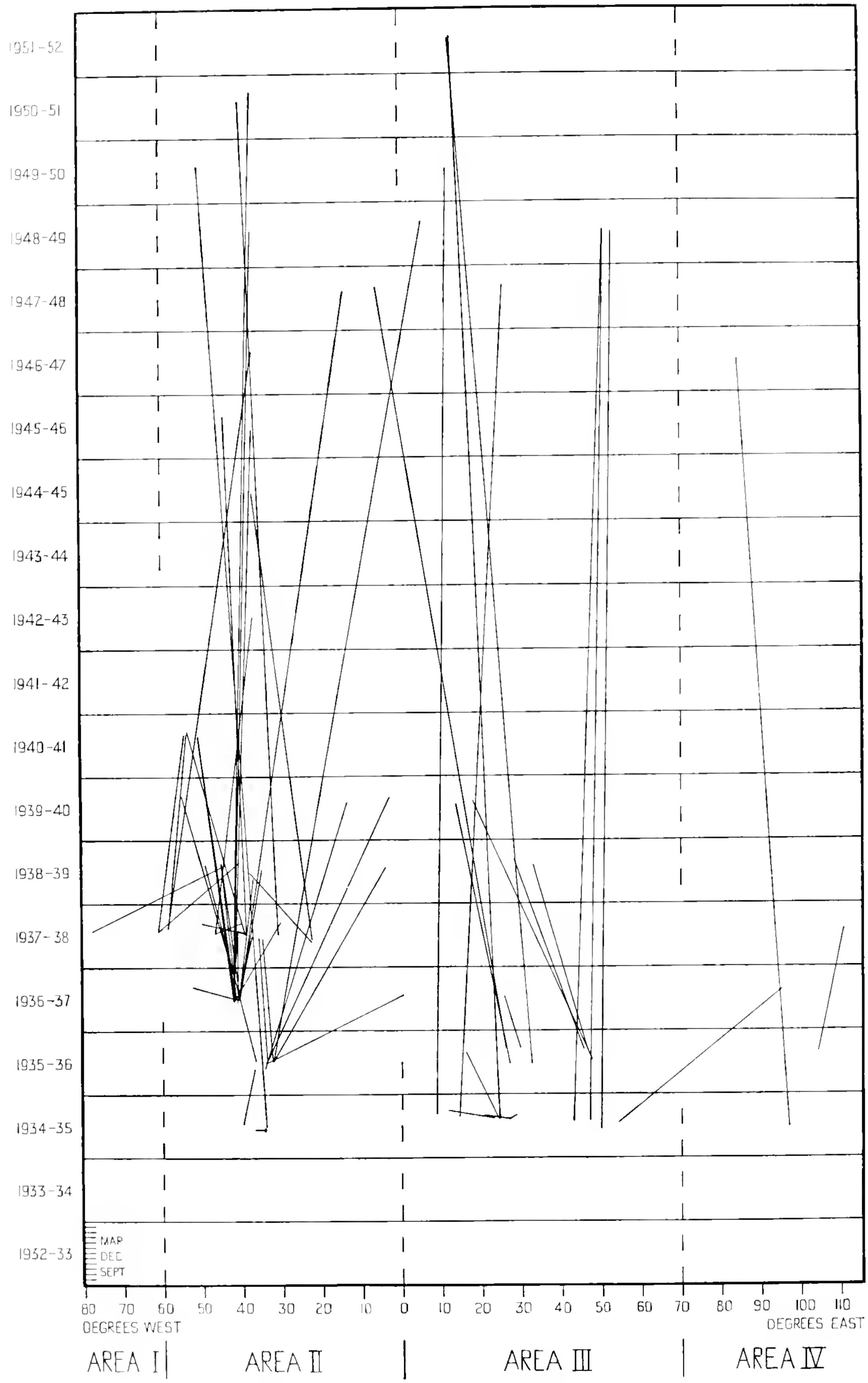

Fig. 4. Time-chart showing dispersal in Fin whales of unknown sex.

contrast between the tracks of males and those of females: very few of the females marked in the South Georgia-Shag Rocks area (35–42° W) have dispersed eastwards, whereas a number of males have done so. The bunched tracks in about 40° W in Fig. 3 seem to represent a local community of whales in which the females have kept closely to their own territory for many years.

Fig. 4 shows the tracks of sixty-two Fin whales of unknown sex. In Area III there is an interesting group of three whales marked and recovered in the same seasons, and showing almost no dispersal after fourteen years.

These time-charts (Figs. 2, 3 and 4) are intended to give an overall view of the east and west movements of Fin whales, and it is worth while, as a further step, to see whether the frequency, rate, and range of dispersal can be more definitely indicated.

Although the time-charts show that most but not all Fin whales are taken near the longitude of marking, they do not give a reliable indication of the proportion of whales which disperse to other longitudes, because the chances of marks being recovered in one sector or another must obviously be affected by the total number of whales killed in the various sectors. For example, if a number of marked whales had dispersed to longitudes where little or no whaling took place, none of them might be recovered and we should have no knowledge of their dispersal; or if a smaller number moved to a region of intense catching several might be recovered and the indication of dispersal would be positively biased. The distribution of the catches does in fact vary considerably (see Figs. 5 and 6), and it is clearly necessary to apply a correction accordingly to the data from recovered marks.

The papers in *Hvalradets Skrifter* mentioned above give, for the seasons 1932–33 to 1936–37, tables showing the number of whales caught by pelagic factory ships in 'squares' measuring 10° of longitude by 10° of latitude south of 50° S, and from these it is easy to obtain the whole catch in each sector of 10° of longitude south of 50° S, which is all that is needed for the present purpose.[1] The Bureau of International Whaling Statistics have kindly supplied similar tables for the seasons 1937–38, 1938–39, and 1945–46 to 1951–52. The catches at South Georgia must also be taken into account. These are given for all years in the Bureau's published International Whaling Statistics, and we have certain unpublished data from which it can be estimated that in the period 1932–37, 96% of Fin whales and 99·85% of Blue whales were taken in the sector 30–40° W and the remainder (4% and 0·15%) in 40–50° W. It has been assumed that these ratios obtain for each season from 1931–32 to 1951–52 inclusive. There remain the pelagic catches in the war-years, and detailed statistics for these are not available. Some British, Norwegian and Japanese factories were operating in 1939–40 and 1940–41, and some marks were recovered in these seasons, but pelagic whaling ceased after 1940–41 until 1945–46, except for one factory which operated in 1943–44 and 1944–45. The *International Whaling Statistics*, No. XXVI, 1951 (p. 23) gives the catch for some of the factories in Areas II–V for 1939–40 and 1940–41, and No. XVII, 1947, gives the total numbers of factories operating in these seasons. From these figures one can calculate a hypothetical distribution of the catch in 10° sectors if one assumes that it was distributed in these sectors in the same ratio as in the two preceding seasons, 1937–38 and 1938–39. This assumption is not very reliable, but it is probably nearer to the truth than to assume that the catch was evenly distributed over all sectors (i.e. to make no allowance for the distribution of the catchers). A similar calculation has been made for the one factory which worked in 1943–44 and 1944–45, and thus we have actual or hypothetical sector totals for all the Fin and Blue whale catches from 1932–33 to 1951–52. These are shown diagrammatically in Figs. 5 and 6.

[1] These tables give rather less than the total Antarctic pelagic catch, but are sufficient to show approximately the distribution of the intensity of catching.

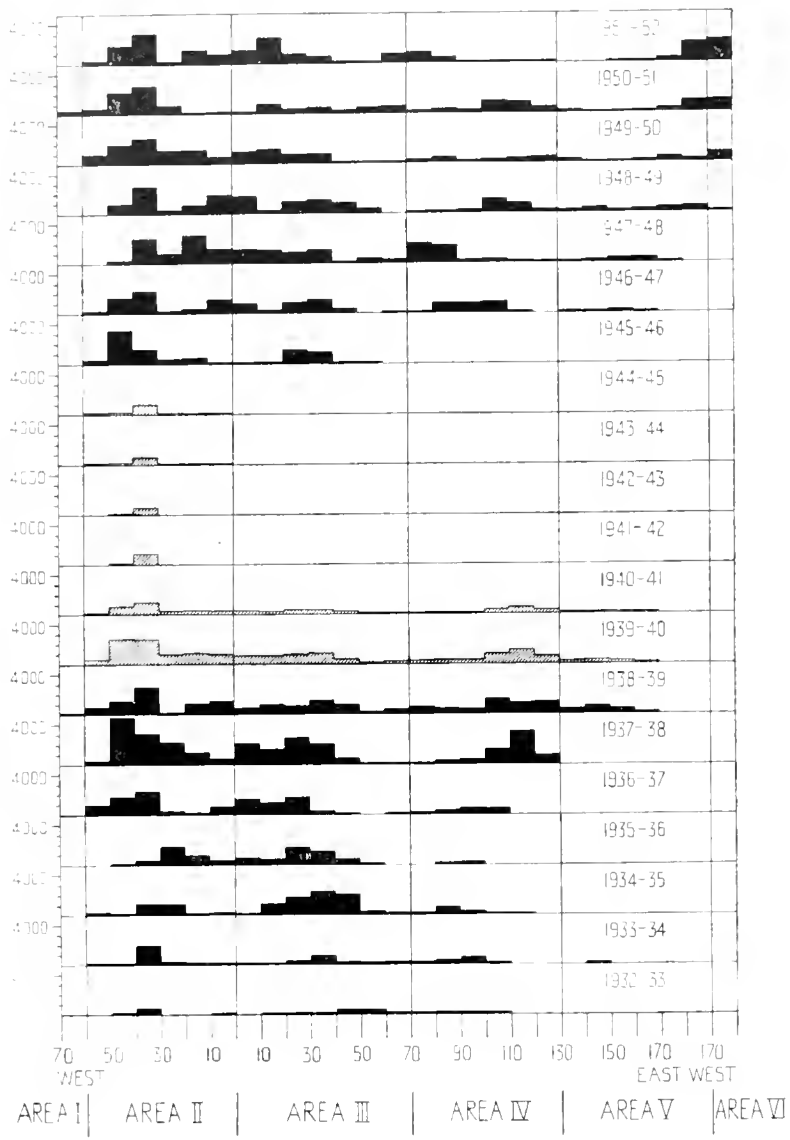

Fig. 5. The distribution of catches of Fin whales in 10° longitude sectors south of 50° S for the seasons 1932–33 to 1951–52. Estimated catches are indicated by light hatching (see text).

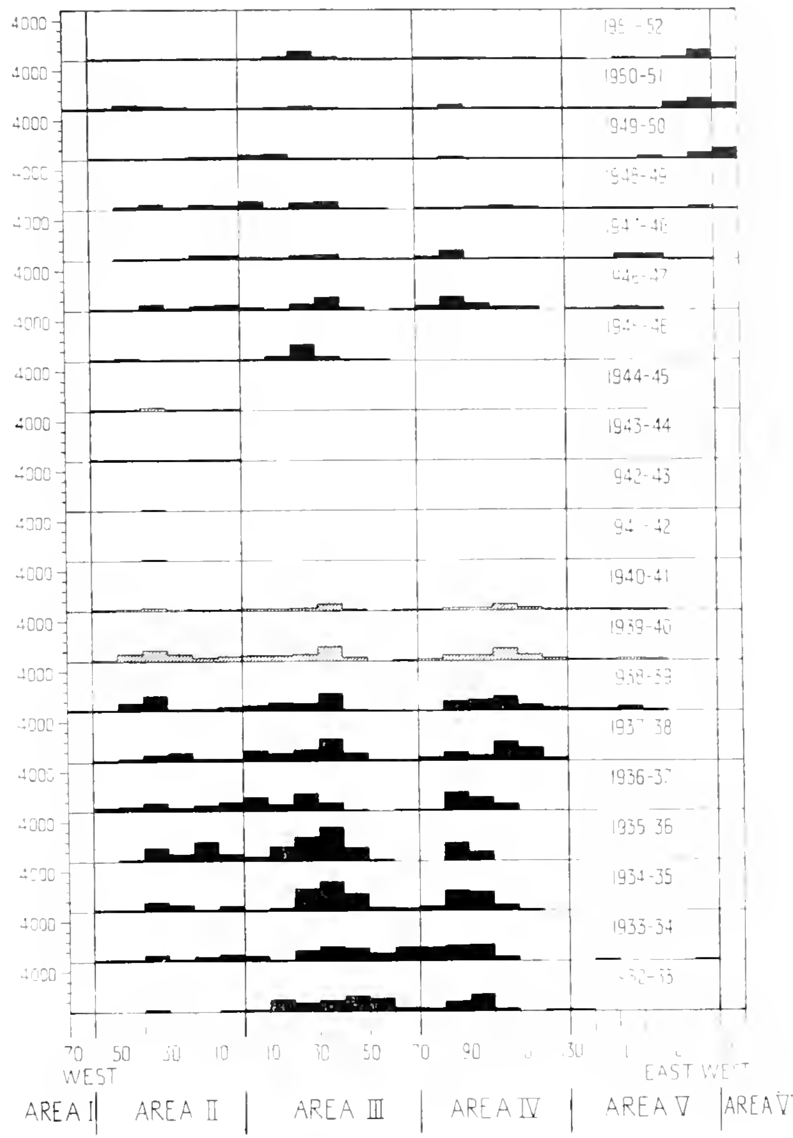

Fig. 6. The distribution of catches of Blue whales in 10° longitude sectors south of 50° S for the seasons 1932–33 to 1951–52. Estimated catches are indicated by light hatching (see text).

The range of dispersal and the proportion of whales found to have dispersed after various periods can be demonstrated (so far as the data allow) by histograms, as in Figs. 7–11. Dispersal is measured horizontally in units of 5° of longitude. Thus a whale which has moved, say, 2° 50′ west of the position of marking will be in the 0–5° W unit, or one moving 17° east will be in the 15–20° E unit. At the centre of the scale 0° is not, of course, the Greenwich meridian; it is any marking position, taken as the zero point from which any whale has eventually moved a certain number of degrees east or west.

Range of dispersal. Simply to show the maximum range of dispersal it is not strictly necessary to apply a correction for the distribution of catches. Fig. 7 shows the total actual numbers of Fin whales marked in Areas II and III, and recovered at different distances east or west of the longitude of marking. (The number of Area IV marks recovered was insignificant.) It is seen that a larger proportion of the marked whales in Area II has been recovered within 10° of the longitude of marking than in Area III. It has to be noted, however, that practically no whaling is carried out in Area I[1] and no marks can be returned from this area; knowledge of the westward dispersal of whales marked in Area II is therefore limited to those recovered east of 60° W, the western boundary of the area. This is probably the explanation of the fact that only one whale marked in Area II has dispersed more than 20° westwards, whereas in Area III a number of whales has done so. It is interesting to note, however, that no whale marked in Area III has moved over a greater distance than 40° westwards, even though a whale marked on the extreme western boundary of Area III could travel up to 60° westwards (to the western boundary of Area II) and still be recovered, as whaling takes place regularly as far as 60° W.

Dispersal eastwards of Fin whales marked in Area II does not extend more than 50°, two whales having moved up to this distance. As whaling takes place regularly in Area III, and in most seasons throughout most of Area IV, it is apparent that a whale marked on the eastern boundary of Area II could be recovered after dispersing over a much greater distance than this. The same thing applies to a less extent in Area III where one whale has moved up to 45° eastwards, although recoveries are possible in Areas IV and V.

It seems, therefore, that there may be a limit to the range of dispersal in Fin whales, although the relatively small number of marks recovered must be remembered in drawing such conclusions.

Dispersal in time. Fig. 8 shows the actual recoveries of marked Fin whales in all Areas, and in Fig. 9 the same data are used but corrected according to the catches in each 10° sector. The correction has been applied as follows. Since there is a greater chance of marked whales being recovered in sectors where catches are high, in any one season the recovery of a marked whale from a sector in which small catches have been made will have more significance in the measurement of range and rate of dispersal, than a recovery from a sector in which catches are large. To allow for this the number of recoveries of marked whales in each 10° sector in a particular season has been multiplied by a coefficient obtained by dividing the average catch for all sectors for that season by the actual catch for each sector in turn. (This coefficient will be small for a sector where a big catch has been made, and large for a sector where a small catch was taken.)

Since rather small numbers of marks are recovered in each season after the first few seasons following marking, separate histograms are shown in Figs. 8 and 9, not for each year-group but for series of three-year-groups. In each of these groups the extreme range of dispersal is included in the figures. In Figs. 10 and 11 the short-term recoveries (0–2 groups) are similarly compared with all the later recoveries (3–17 groups), but the figures are expressed as the percentage of the total in each assembly of groups.

[1] In seasons 1938–39 and 1950–51 there was some whaling between 60–70° W.

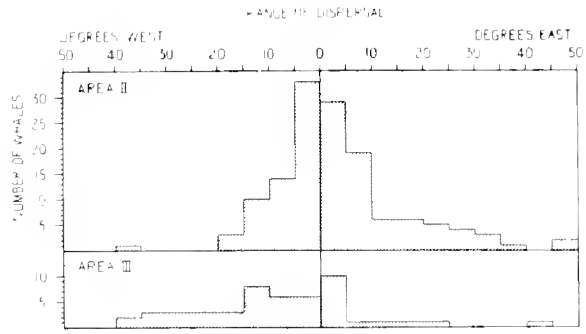

Fig. 7. Maximum range of dispersal in Fin whales.

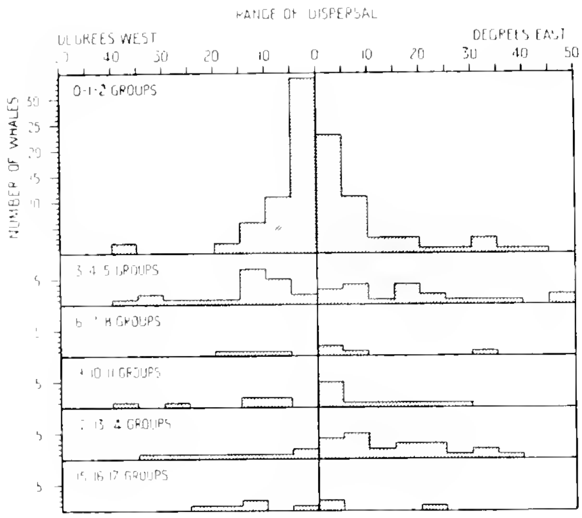

Fig. 8.

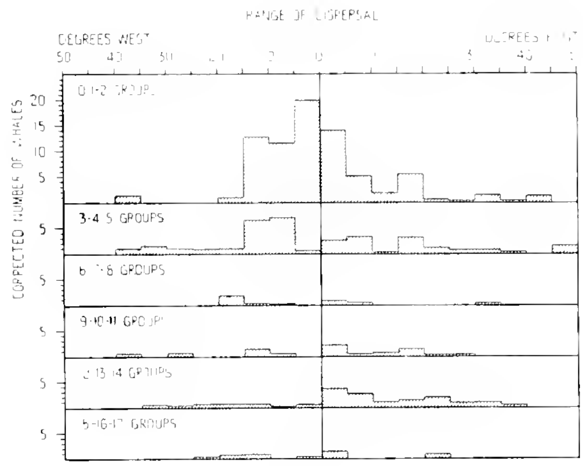

Fig. 9.

Fig. 8. Dispersal in time—Fin whales—actual numbers of marked whales recovered in all areas.

Fig. 9. Dispersal in time—Fin whales—corrected numbers of marked whales recovered in all areas.

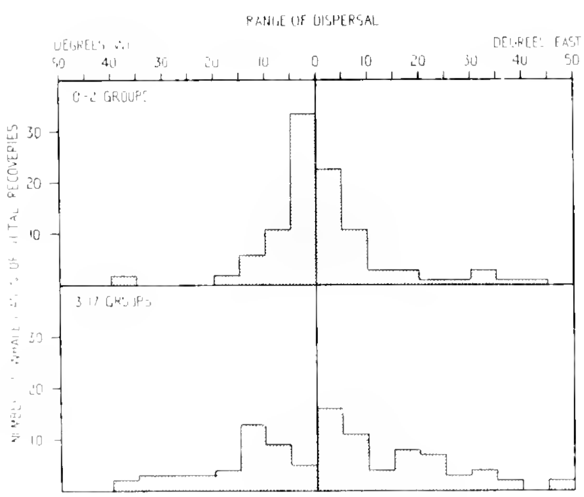

Fig. 10.

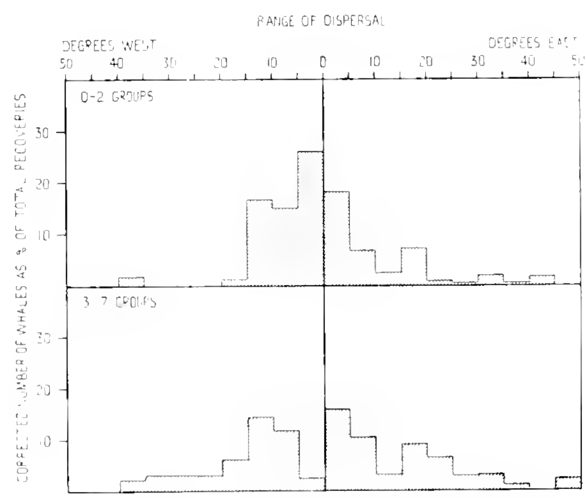

Fig. 11.

Fig. 10. Dispersal in time—Fin whales—actual numbers of marked whales recovered in all areas as percentage of total recoveries in each assembly of groups.

Fig. 11. Dispersal in time—Fin whales—corrected numbers of marked whales recovered in all areas as percentage of total recoveries in each assembly of groups.

It seems curious that the 'corrected' histograms are generally less symmetrical than those for 'actual' numbers of marked whales killed. Perhaps where a few marked whales happen to have been taken in a sector where the catches were small, the correction has given them undue prominence. Nevertheless, more weight must be attached to the corrected than to the uncorrected diagrams.

The following points may be noted:

(*a*) The maximum range of dispersal is within 50° east or west (see pp. 367–8).

(*b*) Among the ninety-nine whales in groups later than 2-group, only two (in the 3–4–5 group series) have gone further than the 102 whales in the 0–1–2 group series, which seems to confirm Rayner's conclusion that the range of dispersal in Fin whales is limited, and not necessarily in itself progressive.

(*c*) Although the range does not appear to increase, it is clear that the proportion of whales which disperse from the immediate area of marking does increase as time goes on. If we say that whales moving more than 10° east or west have 'dispersed', then of the short-term recoveries (0–2 groups) 66% have not dispersed and 34% have done so, as compared with 40% and 60% respectively of the long-term recoveries (3–17 groups).

In Table 2 the same data are grouped in a different way. With the seventeen year-groups divided into three series of six year-groups each, and the range of dispersal into units of 20°, one obtains a fairly good numerical impression of the process of dispersal. It is seen that the percentage of whales remaining in the marking area tends to decline while the percentage which have moved to between 10° and 30° east or west tends to increase. The series 6–11 group is perhaps anomalous in the high percentage of recoveries made between 10° and 30° west because 52·2% of the recoveries used were made by catchers operating from South Georgia, as compared with 24·1% and 18·9% in the series 0–5 groups and 12–17 groups respectively.

Table 2. *Corrected numbers and percentages of marked Fin whales which disperse east or west after various periods*

	West 50°–30°	30°–10°	Marking area 10°–10°	10°–30°	30°–50° East	Total
0–5 groups	3·7 3·4%	23·0 21·0%	63·9 58·3%	13·6 12·4%	5·4 4·9%	109·6
6–11 groups	0·6 4·7%	4·2 33·3%	4·8 38·1%	2·7 21·4%	0·3 2·4%	12·6
12–17 groups	0·6 2·8%	4·4 20·4%	9·0 41·6%	6·2 28·7%	1·4 6·5%	21·6

This is perhaps as far as we can go with the available data. If larger numbers of whales could be marked it may be that eventually some mathematical expression could be found to indicate approximately the rate of dispersal. It is doubtful, however, whether such an expression could ever be very reliable, for dispersal may well be affected by other variable factors in addition to the intensity of whaling.

Since there is a tendency for an increasing proportion of the marked whales to disperse as time goes on, it might be expected that the distance to which they eventually disperse would also increase. So far as the distance goes, however, it would seem that dispersal is limited to about 50° east or west after the first two or three years. This would be explained if for some reason dispersal normally

takes place only within the first two or three years after marking. For example it is not impossible that the discomfort or shock of a whale mark causes some whales to shift their ground, but perhaps a more likely explanation is that it is only the younger, more adventurous whales which normally wander to other longitudes. Many of the short-term marks do show wide dispersal, and it can be supposed that where long-term marks show dispersal the whale was young at the time of marking, that dispersal took place soon afterwards, and that the whale then settled down in limited territory and thereafter kept to the same annual migration route. Whales which show little or no dispersal may be those which were marked at a comparatively advanced age when their habits may be supposed to have already become fixed.

There is, however, little evidence to say whether or not this is the correct explanation, and, in view of the small number of marks returned, it must be remembered that the extremes of dispersal shown by the short-term marks are liable to large chance variations.

DISPERSAL IN BLUE WHALES

Fifty marks have now been returned from forty-five Blue whales, all from known positions. Twelve recoveries have been made since Rayner's report was published, and there are now recoveries in nine year-groups (Table 3). No marks have been returned in 6-group to 10-group inclusive. Details of the sex of the whale and its length when captured have been recorded for twenty-eight of the recoveries, eight males and twenty females. No recoveries of marked Blue whales have yet been made outside the Antarctic.

Table 3. *Marked Blue whales killed in each group*

(See note, p. 377)

Season of marking	Estimated number marked	Returned: Same season 0-group	1st season 1-group	2nd season 2-group	3rd season 3-group	4th season 4-group	5th season 5-group	11th season 11-group	12th season 12-group	13th season 13-group	Returns to date
1932-33	2				-				—	—	—
1934-35	147	10	4	2	1	2	1		1	1	22
1935-36	287	6	3	2					2		13
1936-37	167	1						1			2
1937-38	21	1	1								2
1938-39	90	4	1		—				1		6
Totals	714	22	9	4	1	2	1	1	4	1	45

The tracks of all these whales are shown in Fig. 12; fourteen of the marks were recovered in Area II and thirty-one in Areas III and IV. Two almost vertical tracks are seen, and these represent whales taken in almost the same longitude as that in which they were marked (Mark No. 859 near 35° W, and No. 8743 near 30° E). The other recoveries show greater or lesser degrees of dispersal. If this chart is compared with the time-charts for Fin whales (Figs. 2, 3 and 4) it can hardly be doubted that a higher proportion of Blue than of Fin whales has dispersed, but as in Fin whales the slopes of the tracks generally show more rapid dispersal among the short-term recoveries than among the long-term recoveries. Some whales have crossed the border both ways between Areas III and IV, but not one has crossed between Areas II and III.

As with Fin whales, from the positions of marking and recovery of marked whales, the range of longitude over which Blue whales are known to disperse can be examined. Four Blue whales have

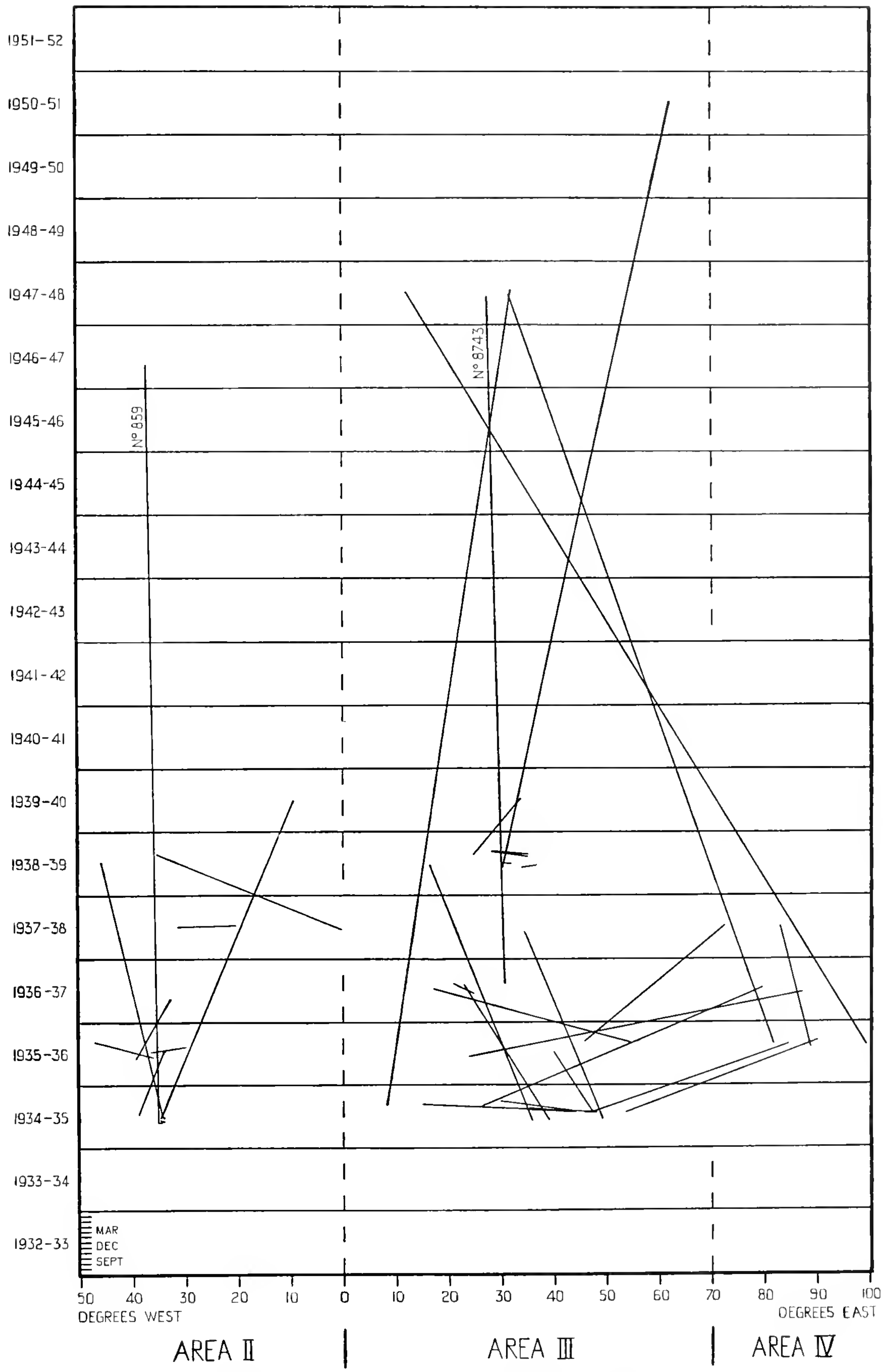

Fig. 12. Time-chart showing dispersal in Blue whales.

been recovered more than 50° of longitude east or west of the position of marking (the maximum recorded dispersal for Fin whales), No. 5456 having moved through almost 87° of longitude (86° 58′), from Area IV westwards into Area III. It seems probable, therefore, that Blue whales disperse over greater distances than Fin whales, but since the number of recoveries is so small, it is not possible to say whether or not the range of dispersal may be limited as appears to be the case in Fin whales.

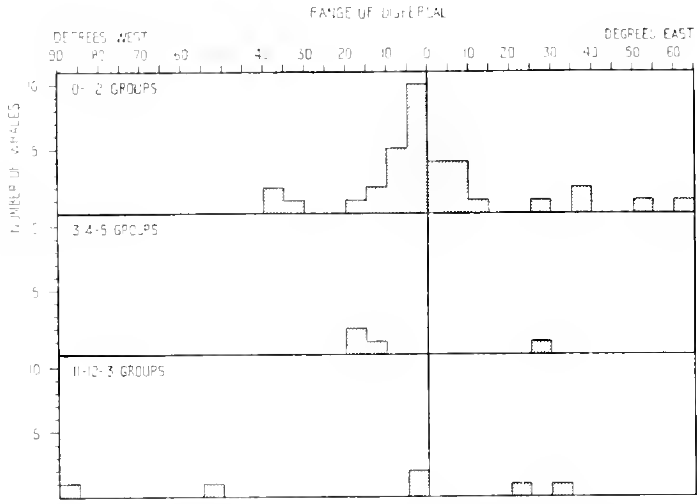

Fig. 13. Dispersal in time—Blue whales—actual numbers of marked whales recovered in all areas.

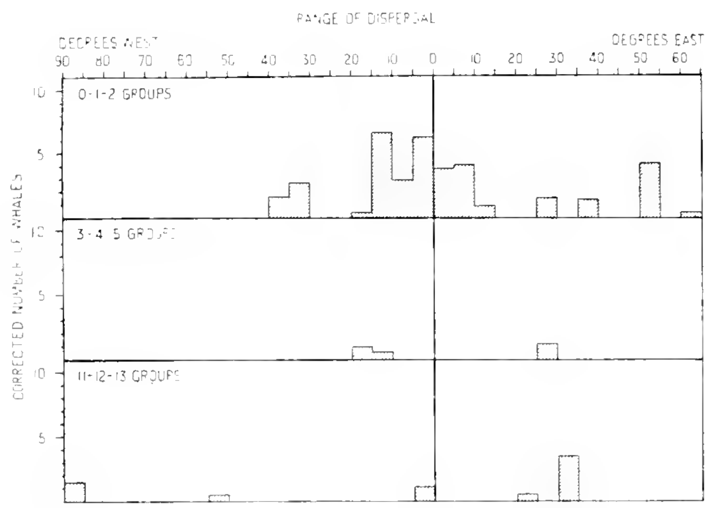

Fig. 14. Dispersal in time—Blue whales—corrected numbers of marked whales recovered in all areas.

For a comparison of dispersal after different periods the actual numbers of recoveries shown in Fig. 13 are divided into three year-group series in the same way as was done with the Fin whale recoveries, the corrected numbers recovered in the various year-groups are similarly shown in Fig. 14. In the 0–1–2 groups 46·5% of the whales have moved less than 10° either way. The recoveries made in later groups suggest that, as in Fin whales, the proportion which have not dispersed is less in the long-term than in the short-term recoveries, but the small number of marks returned does not permit a definite conclusion to be drawn.

MOVEMENTS BETWEEN THE ANTARCTIC AREAS

It has been explained that the division of the Antarctic whaling grounds into Areas I–VI is not purely arbitrary; there are grounds for believing that at least some of them represent a real grouping of the whale populations, more distinct in Humpbacks than in other species. The divisions between the areas, however, may eventually need adjustment and some may have more reality than others. In any case it is worth while to compare the movements of whales between these areas, so far as they have been demonstrated by whale-marking.

In a discussion of the grouping of Blue and Fin whales, Mackintosh (1942) drew attention to the recoveries of whale-marks described by Rayner (1940), and noted that since more whales moved between Areas III and IV, than between Areas II and III, there might be a more real distinction between the two latter. No whale has yet been shown by whale-marking to cross from one area to another within the course of a single whaling season and Mackintosh points out that it seems likely, therefore, that movement from one area into another takes place either in temperate regions or in the course of the migration. Again, no whale has yet been demonstrated to move from one area, across a second area, and into a third, a distance of at least 60° of longitude (70° if across Area III), but two Blue whales, No. 2026 dispersing 63° 10′ eastward and No. 5456 moving 86° 58′ westward travelled a sufficient distance to have done so had they been marked near the boundary of an area. The time-charts for Fin and Blue whales (Figs. 2, 3, 4 and 12) show the movements between Areas I–IV which have been recorded to date. No marked whales have yet been recovered in Area V but whaling was not carried on regularly during every season in this area before 1946–47.

Movements of Fin whales. Twenty-five of the 201 marked Fin whales recovered are known to have moved from one area into another (Table 4). In order to compare the amounts of movement between the different areas it is necessary not only to allow for the number of whales marked in each Area but also to allow for the chance of a marked whale being captured in each Area. For this again a coefficient must be used, which represents the chances of a marked whale being caught in that Area. Here it is convenient to use the ratio of recoveries within the Area rather than the total number caught, and the correction is made as follows. The number of whales marked in the Area (given in Table 5) is divided by the number of these marks recovered in that Area to give a coefficient which will be high when the chances of recovery are low, and vice versa. Then the number of marked whales crossing into the Area has been multiplied by this coefficient to give a corrected number representing the total marked whales calculated to have crossed into the Area, including those not captured. The corrected number has then been expressed as a percentage of the whales marked in the Area from which they have moved.

The calculation is shown in Table 4. Taking the second line as an example, a total of 2233 whales have been marked in Area II, and six of these were recovered in Area III. In Area III 1186 whales had been marked of which forty-two were recovered in the same area, i.e. 1 in 28·24 which is the coefficient. From this it is calculated that 169 or 7·6% of all the whales marked in Area II moved into Area III during the whole period in question, whether or not they were recaptured.

Assuming that the marked whales were a fair sample of the population the implication is that 7·6% of the whole population of Area II moved into Area III in the same period; but of course it must be remembered that the small numbers of marked whales involved does not permit these figures to be used to draw more than a broad comparison between the various movements. The 100% arrived at in the first line of Table 4 is no doubt quite unrealistic, but it seems evident that much more movement takes place in the eastward direction between Areas I and II than between any of the other areas. The corresponding westward movement, from Area II to Area I, cannot be

Table 4. *Movements between Areas I–IV in Fin whales*

	Whales marked in	Marked whales crossing into	Number of whales marked in	Number of these marked whales recovered in	Ratio of chances of capture in	Corrected number of marked whales crossing into	Corrected number as % of whales marked in
				Dispersal eastwards			
I–II	I 152	II 11	II 2233	II 130	II $\frac{2233}{130}=17{\cdot}17$	II $11\times17{\cdot}17=189$	I 100
II–III	II 2233	III 6	III 1186	III 42	III $\frac{1186}{42}=28{\cdot}24$	III $6\times28{\cdot}24=169$	II 7·6
III–IV	III 1186	IV 2	IV 123	IV 4	IV $\frac{123}{4}=30{\cdot}75$	IV $2\times30{\cdot}75=62$	III 5·2
				Dispersal westwards			
IV–III	IV 123	III 1	III 1186	III 42	III $\frac{1186}{42}=28{\cdot}24$	III $1\times28{\cdot}24=28$	IV 22·8
III–II	III 1186	II 5	II 2233	II 130	II $\frac{2233}{130}=17{\cdot}17$	II $5\times17{\cdot}17=86$	III 7·3
II–I	II 2233	I Nil	I 152	I Nil	I —	—	—

Table 5. *Whales estimated to be effectively marked in Areas I–IV*

(See note, p. 377)

Area		Whales effectively marked						
		Blue	Fin	Humpback	Sei	Minke	Right	Sperm
I	1937–38	6	152	34				—
	1938–39		—	5	—	—		—
	Total	6	152	39		—		
II	1932–33	2	202	2	1			
	1934–35	69	299	1		2	6	—
	1935–36	202	584	3			—	—
	1936–37	1	675	—	3	—		—
	1937–38	15	439	14	7			1
	1938–39	14	34	18		—	—	—
	Total	303	2233	38	11	2	6	1
III	1934–35	65	461	18	—	—		5
	1935–36	40	284	35	—	—		13
	1936–37	110	415	42		—	—	14
	1937–38	—	11	—		—	—	—
	1938–39	76	15	15		1	—	—
	Total	291	1186	110	—	1	—	32
IV	1934–35	13	18	49	—	—	—	2
	1935–36	45	47	164	—	—	—	—
	1936–37	56	58	186	—	—	—	4
	Total	114	123	399	—	—	—	6
Total all areas		714	3694	586	11	3	6	39

demonstrated yet since very little whaling has taken place in Area I and no marked whales have been captured there. Since movement in both directions has been demonstrated in the case of the other areas it seems very probable that this movement westwards does in fact take place. The amount of movement between the Areas II and III, and III and IV, appears to be about equal—the high percentage of whales crossing from Area IV into Area III probably being accounted for by the small numbers of marked whales involved.

Movements of Blue whales. Blue whales have been marked in each of the four Areas I–IV (Table 5) but of the forty-five marked whales recovered, the seven showing dispersal from one area to another have all crossed the boundary between Areas III and IV. Five whales have moved in the eastward direction from Area III into Area IV, and two westwards from Area IV to Area III.

Only six Blue whales have been marked in Area I and it is thus extremely unlikely that a dispersal eastwards into Area II will be demonstrated by the recovery of one of these marks. This movement may well take place, however, as it has been shown to do so in Fin whales. It is interesting that no Blue whale has yet been recovered after crossing the boundary between Areas II and III, although about 300 of this species have been marked in each of these areas. So far as the small number of returns allow any conclusion to be drawn, it seems that for Blue whales the separation between Areas II and III is more distinct than that between Areas III and IV.

The results of this comparison of the movements shown by marked whales between the Areas I–IV seem to indicate that there is probably a more distinct separation between Areas II and III than between Areas III and IV, a conclusion suggested by Mackintosh (1942) who used the earlier smaller number of recoveries of marked whales. There would appear to be considerable movement of Fin whales from at least the eastern part of Area I into Area II and it seems likely that the reverse movement also takes place and that there may be a significant exchange of the members of the populations in these two areas.[1]

SUMMARY

1. Over 5000 whales were marked by the Discovery Committee in the Antarctic between 1932 and 1939. 218 marks have been returned from 208 Fin whales, and 50 marks for forty-five Blue whales up to the close of the 1951–52 Antarctic whaling season. A list of these returned marks is given, with details of the positions of marking and recovery, and of sex and length of the whale where this is known.

2. The distribution of the whales marked is shown diagrammatically, and the boundaries of the Antarctic whaling areas indicated on a chart.

3. The dispersal of whales is defined as the ultimate movement of whales eastwards or westwards from the position in which they were marked. A study of dispersal involves the proportion of whales showing dispersal and the range or distance to which they disperse, and the changes in this proportion and range of dispersal over a period of time. Dispersal in Fin and Blue whales is shown on 'time-charts' and by means of histograms, and is discussed separately.

4. Many Fin whales are shown to return from their migrations year after year to somewhere near the place where they were marked. One whale was found after seventeen years less than 1° of longitude away from the position of marking.

In Fin whales the range of dispersal appears to be limited to within 50° east or west of the position of marking, and the dispersal is not necessarily in itself progressive. Within this limit, however, the

[1] Schubert, in a recent paper (1953), expresses the opinion that there is a movement of whales between Areas I and II. This appears to have been based only on the direction in which some whales (seen between 60° and 70° W) were observed to be moving, but his inference is now corroborated.

proportion of whales dispersing with the lapse of time increases. 34% of the short-term recoveries have dispersed compared with 60% of the long-term recoveries.

Migration from the coast of Brazil to South Georgia has been demonstrated.

5. It is suggested that dispersal may take place among the younger whales of the population rather than among older whales.

6. Some Blue whales apparently return to the area of marking year after year, but a higher proportion of marked whales show dispersal than is the case in Fin whales. Blue whales disperse over greater distances than Fin whales, one having moved through almost 87° of longitude. In view of the small number of returns from this species it is not possible to say whether the range of dispersal is limited, nor whether the proportion of whales dispersing with the lapse of time increases.

7. The movements of Fin and Blue whales between the Antarctic whaling areas are discussed. Fin whales are shown to have moved between Areas I and II, II and III, and III and IV, and Blue whales between Areas III and IV. It is suggested that the boundary between Areas II and III is more definite than that between Areas III and IV, and that there may be a significant exchange of individuals between the populations of Areas I and II.

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NOTES ON THE TABLES

Table 1 (p. 361) shows the number of Fin whales killed in each group for each season's marking. The few whales marked by the 'Discovery II' are omitted from this and all other tables but those marked by certain German whaling expeditions which co-operated with the Discovery Committee in 1938–39 are included. The total numbers of whales effectively marked during each season, shown in the first column of figures, are calculated on the basis used by Rayner (1948). Only those actually recorded as hits, together with 'misses' and 'possibles' later recovered have been counted. No duplicate hits, no 'possible hits', and no marks recorded as protruding, except when such a protruding mark has been returned, are included in the total. In the other columns are given the numbers of marked whales reported killed during the same season as they were marked and during subsequent seasons. The single whale recovered in warm waters in the southern winter during the period between the Antarctic whaling seasons appears in $2\frac{1}{2}$-group. The whale marked in warm waters in October 1937 and recovered in the Antarctic appears in 11-group. The final column gives the number of marked whales recovered up to the end of the 1951–52 Antarctic whaling season, for each of the marking seasons.

Table 3 (p. 370) gives the same data for Blue whales. No marks have been returned in 6-group to 10-group inclusive.

Table 5 (p. 374) gives the numbers of whales of each species effectively marked within the boundaries of Areas I–IV in each marking-season. The totals are arrived at in the manner described for Table 1 above. The marking in the 1938–39 season was done by the German expeditions.

Tables 6 and 7 (pp. 378, 380) present a complete list of returned marks for Blue and Fin whales. The dates and positions of marking and of recovery are shown, and the length of the whale carrying the mark, measured when captured, together with its sex, when these details have been given with the returned mark. In a few cases no data have been supplied with the returned marks, and in others only approximate dates and positions of recovery are possible.

The marks are arranged in groups corresponding with those in Tables 1 and 3. Within these groups they are arranged in chronological order of the dates of firing, irrespective of the position of marking. When two or more marks were fired on the same day, they are arranged in numerical order.

The prefix 'G' signifies a mark fired by the German expeditions in the 1938–39 season. In those instances where two marks have been recovered from one whale, the two final digits of the number of the second mark are given after a stroke, it being understood that the preceding digits are the same as the corresponding digits of the accompanying mark. Two exceptions occur, one where the two marks are numbered 656 and 1229, and one where three marks were recovered, numbers 1183, 1205 and 1210. This convention is also used in the text.

APPENDIX

Table 6. *Marks returned from Blue whales*

(See note, p. 377)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			o-group			
825/53	30. xi. 34	30. xi. 34	54° 55′ S, 35° 14′ W	55° 08′ S, 34° 32′ W		—
700	6. xii. 34	11. xii. 34	54° 15′ S, 33° 58′ W	54° 11′ S, 34° 50′ W	♂	78
656/1229	26. xii. 34	29. xii. 34	54° 46′ S, 34° 00′ W 54° 40′ S, 33° 57′ W	54° 30′ S, 34° 19′ W		79
2902	22. i. 35	12. iii. 35	63° 32′ S, 47° 57′ E	c. 66° S, 15° E	—	—
2903	22. i. 35	26. i. 35	63° 32′ S, 47° 57′ E	63° 56′ S, 45° 28′ E	♂	86
2910	24. i. 35	26. i. 35	62° 45′ S, 46° 22′ E	63° 25′ S, 45° 56′ E	♀	69
2960/65	26. i. 35	31. i. 35	62° 46′ S, 43° 05′ E	64° 46′ S, 41° 25′ E	♀	73
2963	26. i. 35	8. ii. 35	62° 39′ S, 43° 58′ E	62° 39′ S, 34° 53′ E		85
2976	26. i. 35	14. ii. 35	62° 48′ S, 43° 04′ E	64° 16′ S, 35° 05′ E	—	—
3013	28. i. 35	27. iii. 35	61° 55′ S, 43° 17′ E	64° 14′ S, 29° 45′ E	♀	75
3853	11. xii. 35	7. iii. 36	56° 08′ S, 36° 01′ W	63° 22′ S, 47° 07′ W	♀	74
4122	27. xii. 35	30. xii. 35	57° 17′ S, 33° 55′ W	54° 34′ S, 33° 42′ W	—	—
4563	11. i. 36	11. ii. 36	55° 19′ S, 36° 39′ W	59° 44′ S, 29° 46′ W	♂	75
4843	18. i. 36	22. i. 36	54° 52′ S, 33° 44′ W	55° 14′ S, 34° 15′ W	—	—
5245	1. ii. 36	8. ii. 36	62° 08′ S, 87° 37′ E	63° 55′ S, 87° 28′ E	♀	88
5525	16. ii. 36	17. ii. 36	63° 15′ S, 94° 19′ E	63° 44′ S, 94° 25′ E	♀	83
7705	13. xii. 36	9. ii. 37	54° 54′ S, 24° 49′ E	61° 07′ S, 20° 50′ E	♀	80
10638	1. i. 38	9. i. 38	58° 48′ S, 31° 22′ W	61° 15′ S, 20° 21′ W	♂	75
G 1309	6. xii. 38	20. xii. 38	59° 25′ S, 33° 50′ E	61° 24′ S, 36° 54′ E	♀	83
G 1305	31. xii. 38	2. i. 39	60° 50′ S, 31° 50′ E	60° 24′ S, 30° 31′ E	—	—
G 1306	9. ii. 39	6. iii. 39	65° 00′ S, 35° 00′ E	65° 27′ S, 28° 09′ E	—	—
G 1370	26. ii. 39	6. iii. 39	65° 14′ S, 35° 00′ E	65° 27′ S, 28° 29′ E	—	—
			1-group			
903	12. i. 35	19. i. 36	54° 01′ S, 38° 51′ W	55° 24′ S, 33° 47′ W	♀	79
2816	17. i. 35	9. iii. 36	63° 21′ S, 53° 32′ E	c. 64° S, 90° E		—
2892	22. i. 35	26. ii. 36	63° 32′ S, 47° 17′ E	65° 17′ S, 84° 30′ E	♂	85
3023	28. i. 35	9. i. 36	62° 01′ S, 43° 21′ E	63° 37′ S, 39° 54′ E	—	—
3771	4. xii. 35	14. xi. 36	54° 11′ S, 39° 15′ W	54° 52′ S, 32° 41′ W	♂	79
2026	14. xii. 35	16. xii. 36	57° 26′ S, 23° 50′ E	61° 00′ S, 87° 00′ E	—	—
5728	2. iii. 36	8. i. 37	63° 49′ S, 54° 24′ E	56° 48′ S, 17° 02′ E	—	—
10427/31	17. xii. 37	24. ii. 39	55° 49′ S, 00° 14′ W	55° 12′ S, 35° 24′ W	♀	73
G 1111	18. ii. 39	12. i. 40	63° 00′ S, 25° 45′ E	c. 63° 50′ S, 33° 40′ E	♂	64
			2-group			
2525	5. xii. 34	1. ii. 37	56° 40′ S, 39° 00′ E	64° 33′ S, 22° 50′ E		75
3528	28. ii. 35	17. i. 37	63° 26′ S, 26° 11′ E	64° 27′ S, 79° 27′ E		74
5261	1. ii. 36	2. i. 38	61° 56′ S, 88° 42′ E	61° 52′ S, 82° 57′ E		—
5800	8. iii. 36	3. i. 38	64° 24′ S, 45° 49′ E	63° 14′ S, 72° 22′ E		77
			3-group			
2548	8. xii. 34	11. xii. 37	58° 21′ S, 49° 16′ E	59° 00′ S, 34° 15′ E	♂	80
			4-group			
2537	4. xii. 34	22. xii. 38	56° 36′ S, 35° 45′ E	57° 37′ S, 16° 28′ E	♀	84
1123/25	29. xii. 34	12. i. 39	55° 00′ S, 34° 20′ W	62° 20′ S, 45° 50′ W	♀	83

Table 6 (*cont.*)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			5-group			
1245	27. xii. 34	30. xii. 39	54° 53′ S, 34° 34′ W	59° 23′ S, 09° 22′ W	—	—
			11-group			
8743	13. ii. 37	Mid-December 1947	64° 52′ S, 30° 42′ E	55–56° S, 26–29° E	—	—
			12-group			
859	30. xi. 34	*c.* 28. xi. 46	54° 54′ S, 35° 14′ W	South Georgia	—	—
5456	13. ii. 36	9. i. 48	63° 57′ S, 99° 19′ E	56° 38′ S, 12° 21′ E	♀	91
5632	22. ii. 36	20. xii. 47	63° 45′ S, 81° 51′ E	57° 23′ S, 31° 40′ E	♀	92
G 1201	7. xii. 38	11. i. 51	59° 00′ S, 30° 00′ E	64° 54′ S, 62° 23′ E	♀	90
			13-group			
3598	8. iii. 35	20. i. 48	63° 23′ S, 08° 18′ E	*c.* 60° S, 32° E	—	—

Table 7. *Marks returned from Fin whales*

(See note, p. 377)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			o-group			
41	20. xii. 32	27. xii. 32	53° 29′ S, 35° 40′ W	54° 21′ S, 35° 24′ W	♀	61
206	28. xii. 32	3. i. 33	54° 41′ S, 34° 53′ W	54° 33′ S, 34° 54′ W	♂	60
462/66	10. i. 33	20. i. 33	54° 02′ S, 37° 46′ W 54° 04′ S, 37° 46′ W	53° 49′ S, 38° 07′ W	♂	60
840	30. xi. 34	Before 18. i. 35	55° 01′ S, 34° 31′ W	South Georgia	—	—
866	30. xi. 34	22. xii. 34	54° 49′ S, 34° 27′ W	53° 43′ S, 34° 31′ W	—	—
2433	1. xii. 34	1. xii. 34	54° 19′ S, 35° 50′ W	54° 10′ S, 34° 41′ W	♀	74
2513	1. xii. 34	20. iii. 35	51° 01′ S, 29° 10′ E	66° 23′ S, 27° 08′ E	♀	63
597	2. xii. 34	2. xii. 34	53° 47′ S, 35° 08′ W	54° 11′ S, 34° 50′ W	♀	71
609	5. xii. 34	Before 7. xii. 34	54° 31′ S, 34° 14′ W	South Georgia	—	—
1051	17. xii. 34	12. ii. 35	53° 22′ S, 39° 32′ W	54° 38′ S, 39° 14′ W	♀	61
2724/25	14. i. 35	*c.* 22. i. 35	64° 17′ S, 56° 11′ E	*c.* 65° S, 49° E	♂	66
1322	15. i. 35	18. i. 35	53° 54′ S, 39° 40′ W	53° 26′ S, 40° 15′ W	♂	—
1081	16. i. 35	31. iii. 35	53° 39′ S, 40° 07′ W	63° 28′ S, 28° 00′ W	♂	67
2750	16. i. 35	25. i. 35	63° 57′ S, 54° 27′ E	65° 13′ S, 50° 58′ E	♂	60
2789	16. i. 35	21. i. 35	64° 00′ S, 54° 03′ E	64° 40′ S, 54° 50′ E	♂	71
2797	16. i. 35	21. i. 35	64° 01′ S, 53° 57′ E	64° 25′ S, 54° 28′ E	♀	70
2857/60	21. i. 35	21. i. 35	63° 57′ S, 48° 58′ E	64° 16′ S, 48° 55′ E	♀	70
2876	21. i. 35	24. i. 35	63° 37′ S, 48° 23′ E	64° 03′ S, 48° 13′ E	♀	65
3172/73	8. ii. 35	14. ii. 35	65° 49′ S, 29° 00′ E	64° 26′ S, 30° 47′ E	♀	58
3192	10. ii. 35	16. ii. 35	63° 28′ S, 26° 54′ E	63° 38′ S, 28° 14′ E	♀	69
3196	10. ii. 35	*c.* 1. iii. 35	63° 28′ S, 26° 54′ E	*c.* 65° S, 20° 30′ E	—	—
3210	10. ii. 35	1. iii. 35	63° 28′ S, 26° 54′ E	64° 43′ S, 28° 37′ E	—	—
3300	12. ii. 35	25. iii. 35	63° 13′ S, 22° 54′ E	67° 47′ S, 11° 37′ E	—	—
2077	16. xii. 35	6. ii. 36	56° 38′ S, 25° 25′ E	64° 37′ S, 28° 48′ E	♂	70
4132	27. xii. 35	5. i. 36	54° 17′ S, 33° 55′ W	54° 48′ S, 33° 33′ W	♂	66
6554	29. xii. 36	25. i. 37	53° 24′ S, 41° 32′ W	64° 26′ S, 45° 51′ W	♂	68
6609	30. xii. 36	7. iii. 37	52° 58′ S, 41° 56′ W	64° 30′ S, 52° 30′ W	—	—
6628	3. i. 37	4. i. 37	54° 26′ S, 34° 14′ W	54° 48′ S, 34° 28′ W	♂	57
7036	21. i. 37	16. ii. 37	54° 38′ S, 30° 45′ W	64° 15′ S, 38° 56′ W	♀	69
8728	13. ii. 37	3. iii. 37	64° 41′ S, 30° 16′ E	62° 45′ S, 20° 22′ E	♂	71
10679	2. i. 38	24. i. 38	59° 17′ S, 32° 30′ W	62° 29′ S, 34° 13′ W	♂	65
10723	7. i. 38	3. ii. 38	59° 22′ S, 33° 00′ W	63° 44′ S, 39° 53′ W	♀	72
10728	7. i. 38	18. i. 38	59° 22′ S, 33° 04′ W	61° 30′ S, 40° 30′ W	♂	69
10762	9. i. 38	19. i. 38	59° 33′ S, 38° 51′ W	62° 06′ S, 41° 11′ W	—	—
10765	9. i. 38	24. i. 38	59° 33′ S, 38° 51′ W	62° 25′ S, 41° 59′ W	♂	70
10776	9. i. 38	3. iii. 38	59° 33′ S, 38° 53′ W	61° 26′ S, 50° 05′ W	—	—
10826	10. i. 38	11. ii. 38	59° 57′ S, 40° 36′ W	63° 51′ S, 39° 20′ W	♀	65
10881	11. i. 38	10. ii. 38	59° 55′ S, 41° 42′ W	63° 27′ S, 45° 02′ W	♀	64
10882	11. i. 38	13. ii. 38	59° 55′ S, 41° 42′ W	62° 57′ S, 43° 29′ W	♂	65
10883	11. i. 38	16. i. 38	59° 55′ S, 41° 42′ W	60° 50′ S, 42° 00′ W	♂	65
10903	12. i. 38	6. iii. 38	60° 02′ S, 46° 46′ W	63° 12′ S, 40° 11′ W	—	—
10946	14. i. 38	27. ii. 38	61° 06′ S, 47° 19′ W	62° 34′ S, 40° 33′ W	♂	62
10949	14. i. 38	1. iii. 38	61° 06′ S, 47° 19′ W	61° 30′ S, 43° 30′ W	♂	68

Table 7 (*cont.*)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			1-group			
223	28. xii. 32	27. i. 34	54° 41′ S, 34° 53′ W	53° 59′ S, 36° 13′ W	♀	57
248	28. xii. 32	31. i. 34	54° 41′ S, 34° 53′ W	54° 02′ S, 36° 17′ W	♂	66
1233	26. xii. 34	4. xii. 35	54° 44′ S, 33° 59′ W	56° 28′ S, 17° 58′ W	♂	65
1006	13. i. 35	25. xi. 35	54° 05′ S, 39° 58′ W	53° 40′ S, 37° 00′ W	—	—
2982	27. i. 35	29. i. 36	62° 27′ S, 42° 49′ E	62° 20′ S, 40° 13′ E	♂	70
3261	11. ii. 35	27. ii. 36	63° 33′ S, 24° 06′ E	68° 15′ S, 16° 00′ E	—	
4091	27. xii. 35	20. i. 37	54° 16′ S, 34° 04′ W	60° 00′ S, 00° 24′ E	—	69
5941	17. iii. 36	16/19. i. 37	64° 08′ S, 29° 49′ E	c. 62° 20′ S, 25° 40′ E	—	—
6211	13. xii. 36	23. xii. 37	54° 29′ S, 41° 19′ W	60° 53′ S, 37° 30′ W	—	—
6252	14. xii. 36	15. iii. 38	53° 33′ S, 42° 02′ W	61° 14′ S, 30° 10′ W	—	—
6256	14. xii. 36	10. iv. 38	53° 33′ S, 42° 02′ W	c. 54° 20′ S, 36° 10′ W	♀	70
6308	14. xii. 36	12. ii. 38	53° 33′ S, 42° 02′ W	63° 20′ S, 40° 00′ W	♀	67
6353	15. xii. 36	14. i. 38	53° 33′ S, 42° 02′ W	54° 07′ S, 36° 21′ W	♀	69
6371	15. xii. 36	28. ii. 38	53° 33′ S, 42° 02′ W	62° 33′ S, 43° 57′ W	♂	67
6427	15. xii. 36	27. ii. 38	53° 33′ S, 42° 02′ W	62° 30′ S, 44° 00′ W	♀	62
6473	27. xii. 36	1. i. 38	53° 32′ S, 40° 55′ W	60° 58′ S, 41° 14′ W	—	—
6597	30. xii. 36	16. ii. 38	53° 00′ S, 41° 42′ W	63° 21′ S, 39° 17′ W	♂	67
6810	9. i. 37	12. i. 38	53° 36′ S, 42° 34′ W	61° 35′ S, 45° 10′ W	♀	60
6819	9. i. 37	19. i. 38	53° 36′ S, 42° 34′ W	62° 06′ S, 41° 11′ W	—	—
6890	11. i. 37	4. ii. 38	53° 32′ S, 40° 38′ W	54° 48′ S, 35° 17′ W	♂	64
6900	11. i. 37	26. i. 38	53° 32′ S, 40° 38′ W	54° 29′ S, 34° 59′ W	♂	65
6915	11. i. 37	7. ii. 38	53° 32′ S, 40° 38′ W	63° 41′ S, 39° 48′ W	♂	68
6918	11. i. 37	4. ii. 38	53° 32′ S, 40° 38′ W	54° 42′ S, 35° 09′ W	♀	60
6946	11. i. 37	Before 18. iii. 38	53° 32′ S, 40° 38′ W	c. 61° 00′ S, 53° 30′ W	—	—
7002/32	21. i. 37	21. xii. 37	54° 38′ S, 30° 45′ W	53° 43′ S, 35° 10′ W	♂	62
7258	30. i. 37	24. i. 38	53° 20′ S, 42° 26′ W	54° 25′ S, 34° 58′ W	♂	65
10308	26. xi. 37	24. xii. 38	57° 28′ S, 22° 41′ W	59° 04′ S, 38° 00′ W	—	—
10515	21. xii. 37	1938/39	54° 48′ S, 00° 48′ W	—	—	—
10517	21. xii. 37	5. iii. 39	54° 48′ S, 00° 48′ W	63° 46′ S, 40° 22′ W	♂	68
10577	24. xii. 37	6. iii. 39	57° 36′ S, 11° 46′ W	64° 24′ S, 21° 37′ W	♀	73
11014/15	17. i. 38	4. ii. 39	61° 18′ S, 49° 58′ W	62° 31′ S, 46° 33′ W	♀	55
11030	19. i. 38	22. ii. 39	61° 20′ S, 61° 03′ W	65° 09′ S, 40° 42′ W	—	—
11075	23. i. 38	3. ii. 39	68° 02′ S, 77° 56′ W	62° 23′ S, 44° 13′ W	—	—
11106	30. i. 38	27. i. 39	66° 10′ S, 73° 21′ W	61° 58′ S, 37° 21′ W	♂	63
10240	4. ii. 38	6. xii. 38	62° 37′ S, 58° 54′ W	53° 30′ S, 30° 10′ W	♀	65
			2-group			
1167	29. xii. 34	28. ii. 37	55° 09′ S, 33° 58′ W	62° 08′ S, 35° 45′ W	♂	70
1001	13. i. 35	1. iii. 37	54° 03′ S, 39° 24′ W	62° 19′ S, 36° 33′ W	♀	74
1034	13. i. 35	3. ii. 37	54° 03′ S, 39° 24′ W	53° 54′ S, 38° 48′ W	♀	69
2770/71	16. i. 35	22. ii. 37	64° 00′ S, 54° 03′ E	62° 55′ S, 95° 09′ E	—	—
2807	16. i. 35	5. i. 37	64° 02′ S, 54° 00′ E	61° 54′ S, 72° 07′ E	♀	74
4416	4. i. 36	11. xii. 37	55° 39′ S, 32° 18′ W	60° 58′ S, 34° 56′ W	—	—
4438	6. i. 36	23. i. 38	55° 39′ S, 32° 18′ W	61° 18′ S, 20° 20′ W	♀	74
4661	13. i. 36	14. xii. 37	55° 28′ S, 33° 51′ W	61° 08′ S, 35° 56′ W	—	—
4669	13. i. 36	22. ii. 38	55° 28′ S, 33° 51′ W	62° 23′ S, 18° 15′ W	♀	69
5436	11. ii. 36	27. i. 38	64° 27′ S, 104° 04′ E	63° 02′ S, 110° 43′ E	—	—
5834	9. iii. 36	3. iii. 38	64° 10′ S, 45° 29′ E	63° 10′ S, 06° 10′ E	♂	70
5848	9. iii. 36	2. iii. 38	64° 10′ S, 45° 29′ E	60° 32′ S, 35° 30′ E	♀	73
5861	9. iii. 36	7. iii. 38	64° 03′ S, 45° 17′ E	68° 49′ S, 27° 16′ E	♀	61
6324	15. xii. 36	19. ii. 39	53° 33′ S, 42° 02′ W	61° 58′ S, 48° 47′ W	♀	65

Table 7 (*cont.*)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			2-group (*cont.*)			
6389	15. xii. 36	11. i. 39	53° 33′ S, 42° 02′ W	61° 37′ S, 54° 15′ W	♂	67
6480	27. xii. 36	20. xi. 38	53° 32′ S, 40° 55′ W	South Georgia	—	—
6522/61	28/29. xii. 36	12. ii. 39	*c.* 53° 27′ S, 41° 39′ W	61° 32′ S, 49° 26′ W	♂	63
6530	28. xii. 36	15. ii. 39	*c.* 53° 27′ S, 41° 39′ W	63° 18′ S, 45° 12′ W	—	—
6877	11. i. 37	13. i. 39	53° 32′ S, 40° 38′ W	*c.* 55° 09′ S, 35° 04′ W	—	—
6935	11. i. 37	16. ii. 39	53° 31′ S, 40° 39′ W	63° 54′ S, 45° 13′ W	—	—
6968	11. i. 37	10. ii. 39	53° 31′ S, 40° 39′ W	63° 34′ S, 41° 07′ W	♂	68
10251	21. xi. 37	9. ii. 40	56° 49′ S, 16° 17′ W	62° 54′ S, 09° 29′ W	♂	72
10504	21. xii. 37	16. iii. 40	54° 46′ S, 00° 44′ W	66° 50′ S, 13° 41′ W	♀	71
10519	21. xii. 37	14. ii. 40	54° 46′ S, 00° 55′ W	62° 15′ S, 02° 05′ W	♂	63
11141	31. i. 38	27. xii. 39	65° 30′ S, 69° 25′ W	58° 20′ S, 37° 20′ W	♂	64
			2½-group			
3482	24. ii. 35	30. vi. 37	64° 52′ S, 22° 30′ E	*c.* 33° 04′ S, 17° 50′ E	♀	69
			3-group			
842	29. xi. 34	23. i. 38	54° 55′ S, 35° 14′ W	57° 47′ S, 11° 18′ E	♂	66
590	5. xii. 34	15. ii. 38	54° 34′ S, 34° 21′ W	61° 57′ S, 16° 28′ W	♂	71
1000	13. i. 35	29. xii. 37	54° 05′ S, 39° 58′ W	53° 54′ S, 35° 09′ W	♀	72
1097	15. i. 35	13. i. 38	53° 54′ S, 39° 40′ W	61° 01′ S, 41° 27′ W	♀	71
1443	25. i. 35	16. i. 38	54° 45′ S, 40° 50′ W	60° 42′ S, 23° 13′ W	♂	68
1477	25. i. 35	17. i. 38	54° 06′ S, 40° 23′ W	53° 59′ S, 35° 22′ W	♂	65
1486	25. i. 35	12. ii. 38	54° 06′ S, 40° 23′ W	63° 09′ S, 43° 46′ W	♂	70
4368	4. i. 36	24. i. 39	55° 39′ S, 32° 18′ W	62° 09′ S, 03° 49′ W	—	—
4543	11. i. 36	9. ii. 39	55° 19′ S, 36° 39′ W	61° 36′ S, 49° 18′ W	—	68
5601	19. ii. 36	27. xii. 38	63° 27′ S, 90° 19′ E	64° 21′ S, 106° 22′ E	♀	70
5784	8. iii. 36	3. ii. 39	64° 42′ S, 46° 32′ E	64–66° S, 31–35° E	—	—
5818	9. iii. 36	6. iii. 39	64° 14′ S, 45° 23′ E	65° 27′ S, 28° 09′ E	—	—
5997	19. iii. 36	31. i. 39	64° 25′ S, 23° 10′ E	60° 48′ S, 11° 10′ W	♀	66
6969	11. i. 37	3–11. iii. 40	53° 31′ S, 40° 39′ W	*c.* 62° S, 55° W	—	—
10303	26. xi. 37	15. xii. 40	57° 29′ S, 22° 41′ W	53° 10′ S, 36° 30′ W	♂	68
10781	9. i. 38	17. iii. 41	59° 47′ S, 39° 23′ W	64° 04′ S, 53° 26′ W	—	—
10994	15. i. 38	19. xi. 40	61° 15′ S, 45° 53′ W	52° 28′ S, 35° 19′ W		67
11049	19. i. 38	*c.* 25/26. ii. 41	61° 19′ S, 61° 01′ W	*c.* 65° 20′ S, 54° 10′ W	—	—
10210	30. i. 38	17. xii. 40	66° 08′ S, 73° 59′ W	53° 10′ S, 36° 30′ W	♀	67
11173	4. ii. 38	*c.* 3/4. iii. 41	62° 39′ S, 58° 29′ W	*c.* 64° 28′ S, 53° 36′ W	—	—
			4-group			
235	28. xii. 32	10. xii. 36	54° 41′ S, 34° 53′ W	53° 52′ S, 40° 16′ W	♂	68
484	11. i. 33	16. ii. 37	54° 11′ S, 38° 06′ W	57° 49′ S, 09° 05′ E	♂	64
2679	30. xii. 34	11. i. 39	60° 40′ S, 92° 50′ E	63° 33′ S, 110° 07′ E	♀	72
901	2. i. 35	23. xii. 38	53° 47′ S, 38° 42′ W	54° 31′ S, 34° 00′ W	♂	68
2898	22. i. 35	1. iii. 39	63° 30′ S, 47° 37′ E	61° 05′ S, 10° 05′ E	♂	70
3728	26. xi. 35	30. i. 40	54° 58′ S, 34° 22′ W	60° 23′ S, 13° 32′ W	—	—
2485	18. xii. 35	19. i. 40	56° 58′ S, 26° 57′ E	55° 46′ S, 13° 48′ E	—	—
4113	27. xii. 35	1. iii. 40	54° 16′ S, 34° 04′ W	66° 41′ S, 02° 44′ W	—	—
5042	15. i. 36	12. ii. 40	62° 16′ S, 47° 34′ E	*c.* 64° 30′ S, 18° 00′ E	—	—
6030	20. iii. 36	9. ii. 40	64° 18′ S, 23° 52′ E	62° 48′ S, 03° 33′ E	♀	71
6338	15. xii. 36	17. ii. 41	53° 33′ S, 42° 02′ W	64° 39′ S, 51° 45′ W	♂	67
6392	15. xii. 36	*c.* 19. ii. 41	53° 33′ S, 42° 02′ W	*c.* 65° 49′ S, 50° 46′ W	—	—
6756	9. i. 37	*c.* 19. ii. 41	53° 08′ S, 42° 03′ W	*c.* 65° 49′ S, 50° 46′ W	—	—
11048	19. i. 38	6. xii. 41	61° 19′ S, 61° 01′ W	52° 50′ S, 36° 30′ W	♀	70

Table 7 (*cont.*)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			5-group			
3269	11. ii. 35	8. ii. 40	63° 32′ S, 24° 08′ E	66° 00′ S, 06° 22′ W		71
3303	12. ii. 35	10. ii. 40	63° 13′ S, 22° 54′ E	63° 42′ S, 17° 36′ E	♀	74
3425	18. ii. 35	27. ii. 40	61° 42′ S, 05° 59′ E	66° 07′ S, 05° 49′ W	♂	68
6706	7. i. 37	4. ii. 42	53° 39′ S, 40° 56′ W	54° 03′ S, 35° 31′ W	♂	65
10898	12. i. 38	31. xii. 42	60° 02′ S, 46° 45′ W	South Georgia	—	—
			6-group			
696	11. xii. 34	26. ii. 41	54° 45′ S, 34° 51′ W	65° 15′ S, 54° 22′ W		76
6290	14. xii. 36	12. iv. 43	53° 33′ S, 42° 02′ W	South Georgia	♀	—
11155	31. i. 38	17. i. 44	65° 17′ S, 69° 16′ W	54° 30′ S, 34° 34′ W	♂	68
			7-group			
10379	7. xii. 37	9. xii. 44	55° 18′ S, 22° 13′ W	South Georgia	—	—
			8-group			
6582	29. xii. 36	1. xii. 44	53° 15′ S, 41° 33′ W	53° 38′ S, 36° 53′ W	♀	75
10774	9. i. 38	23. ii. 46	59° 33′ S, 38° 51′ W	62° 14′ S, 44° 06′ W	—	—
10849	10. i. 38	16. xii. 45	60° 00′ S, 40° 38′ W	53° 42′ S, 36° 10′ W	♂	67
			9-group			
6306	14. xii. 36	*c.* 10. xii. 45	53° 33′ S, 42° 02′ W	South Georgia		
6361	15. xii. 36	1945/46	53° 33′ S, 42° 02′ W	—	—	
6954	11. i. 37	8. iii. 46	53° 31′ S, 40° 39′ W	53° 46′ S, 38° 40′ W	♀	70
10527	21. xii. 37	13. ii. 47	54° 43′ S, 00° 59′ W	61° 32′ S, 03° 57′ E	♂	68
10583	24. xii. 37	25. ii. 47	57° 37′ S, 12° 12′ W	62° 41′ S, 01° 17′ E	♂	68
10836	10. i. 38	1946/47	60° 00′ S, 40° 38′ W	—	—	—
10238	4. ii. 38	27. ii. 47	62° 37′ S, 58° 49′ W	South Georgia	—	—
G 901	30. xi. 38	21. xii. 47	58° 15′ S, 23° 00′ W	54° 07′ S, 32° 44′ W	♂	70
			10-group			
902	2. i. 35	20. xii. 44	53° 47′ S, 38° 42′ W	53° 02′ S, 36° 04′ W	♂	67
			11-group			
1183/1205/10	18. i. 35	5. ii. 46	54° 11′ S, 39° 23′ W 54° 10′ S, 39° 14′ W	61° 58′ S, 46° 01′ W	♂	72
1488	25. i. 35	4. ii. 46	54° 05′ S, 40° 19′ W	58° 49′ S, 22° 59′ W	♂	68
2920	25. i. 35	7. iii. 46	62° 34′ S, 46° 03′ E	63° 44′ S, 33° 04′ E	♀	72
2984	27. i. 35	10. iii. 46	62° 32′ S, 42° 41′ E	64° 30′ S, 30° 56′ E	♀	70
4568	11. i. 36	20. i. 47	55° 19′ S, 36° 39′ W	53° 36′ S, 34° 28′ W	♂	69
5946	18. iii. 36	11. ii. 47	63° 57′ S, 29° 32′ E	61° 29′ S, 01° 14′ E	♂	71
7972	4. i. 37	19. ii. 48	60° 47′ S, 70° 14′ E	67° 27′ S, 31° 19′ E	♀	69
6676	7. i. 37	*c.* 13. ii. 48	53° 39′ S, 40° 56′ W	*c.* 62° S, 14° W	—	—
7272	30. i. 37	7. i. 48	53° 20′ S, 42° 26′ W	52° 42′ S, 39° 21′ W		80
9340	11. x. 37	7. i. 49	28° 03′ S, 46° 17′ W	52° 55′ S, 38° 42′ W	♂	73

Table 7 (*cont.*)

Mark no.	Date fired	Date recovered	Position fired	Position recovered	Sex	Length in feet
			12-group			
2650	28. xii. 34	5. i. 47	60° 47′ S, 96° 54′ E	58° 58′ S, 84° 29′ E	—	—
4938	21. xii. 35	13. i. 48	59° 01′ S, 32° 16′ E	58° 32′ S, 15° 49′ E	♀	73
4114	27. xii. 35	9. ii. 48	54° 16′ S, 34° 04′ W	61° 35′ S, 13° 56′ W	♂	68
4552	11. i. 36	1. i. 48	55° 19′ S, 36° 39′ W	58° 00′ S, 05° 40′ W	♂	66
6053	21. iii. 36	2. iii. 48	63° 54′ S, 25° 58′ E	62° 51′ S, 05° 53′ W	—	71
6489	28. xii. 36	5. ii. 49	53° 25′ S, 41° 31′ W	62° 46′ S, 11° 47′ W	♂	69
6798	8. i. 37	*c.* 23. i. 49	53° 08′ S, 42° 03′ W	South Georgia	—	—
10209	30. i. 38	5. iii. 50	66° 09′ S, 73° 57′ W	62° 30′ S, 40° 42′ W	♀	72
11127	31. i. 38	22. ii. 50	65° 31′ S, 69° 24′ W	61° 16′ S, 51° 57′ W	♀	72
G 155	29. xi. 38	12. xi. 50	53° 46′ S, 54° 33′ W	52° 55′ S, 38° 42′ W	♀	72
			13-group			
412	7. i. 33	17. i. 46	53° 18′ S, 41° 39′ W	58° 31′ S, 17° 26′ W	♂	71
887	2. i. 35	29. i. 48	53° 44′ S, 38° 48′ W	59° 12′ S, 16° 10′ W	♂	70
3451	20. ii. 35	12. iii. 48	61° 33′ S, 14° 30′ E	68° S, 26° E	—	—
4405	4. i. 36	*c.* 13. iii. 49	55° 39′ S, 32° 18′ W	68° 58′ S, 05° 40′ E	—	—
6293	14. xii. 36	7. xii. 49	53° 33′ S, 42° 02′ W	53° 24′ S, 37° 53′ W	♀	78
6739	8. i. 37	14. xii. 49	53° 15′ S, 41° 50′ W	53° 14′ S, 34° 03′ W	♀	73
6895	11. i. 37	1949 50	53° 31′ S, 40° 39′ W	—	—	—
10637	1. i. 38	Jan. Feb. 1951	58° 46′ S, 30° 58′ W	*c.* 61° S, 40° W	—	—
10937	14. i. 38	8. i. 51	60° 44′ S, 48° 19′ W	56° S, 40° W	♂	70
11186	4. ii. 38	12. i. 51	62° 40′ S, 58° 41′ W	61° 10′ S, 48° 07′ W	♂	68
			14-group			
594	4. xii. 34	20. i. 49	53° 45′ S, 34° 49′ W	53° 21′ S, 39° 31′ W	♀	74
2551	8. xii. 34	*c.* 9. i. 49	58° 25′ S, 49° 50′ E	*c.* 64° S, 53° E	—	—
973	30. xii. 34	15. ii. 49	54° 26′ S, 34° 51′ W	61° 07′ S, 38° 52′ W	♂	69
2993	27. i. 35	*c.* 20. i. 49	62° 27′ S, 42° 49′ E	*c.* 65° S, 51° E	—	—
3058	29. i. 35	*c.* 20. i. 49	62° 06′ S, 46° 55′ E	*c.* 65° S, 51° E	—	—
3246	11. ii. 35	24. i. 49	63° 33′ S, 24° 06′ E	57° 47′ S, 04° 59′ W	♂	68
5813	8. iii. 36	24. xii. 49	64° 18′ S, 45° 30′ E	56° 34′ S, 22° 55′ E	♂	68
6376	15. xii. 36	21. iii. 51	53° 33′ S, 42° 02′ W	South Georgia	—	—
6808	9. i. 37	20. xi. 50	53° 25′ S, 41° 31′ W	51° 37′ S, 37° 27′ W	♀	70
11026	19. i. 38	11. i. 52	61° 19′ S, 61° 05′ W	*c.* 59° S, 43° W	♀	—
			15-group			
813	19. xii. 34	2. i. 50	54° 07′ S, 40° 55′ W	59° 02′ S, 41° 28′ W	♂	70
654	26. xii. 34	25. i. 50	54° 41′ S, 34° 05′ W	61° 40′ S, 50° 25′ W	—	—
3582	7. iii. 35	*c.* 15. i. 50	63° 27′ S, 08° 38′ E	*c.* 60° S, 12° E	—	—
			16-group			
2467	18. xii. 35	10. i. 52	56° 58′ S, 26° 57′ E	57° S, 12° E	♂	70
4944	21. xii. 35	*c.* 23. i. 52	59° 09′ S, 32° 39′ E	*c.* 56° 31′ S, 12° 35′ E	—	—
4218	29. xii. 35	1951 52	54° 37′ S, 32° 33′ W		—	—
5860	9. iii. 36	23. ii. 52	64° 03′ S, 45° 17′ E	*c.* 65° 05′ S, 65° 46′ E	♀	70
			17-group			
3204	10. ii. 35	4. iii. 52	63° 28′ S, 26° 54′ E	66° 50′ S, 27° 38′ E	♀	77
3259	11. ii. 35	*c.* 2. ii. 52	63° 32′ S, 24° 08′ E	*c.* 58° 53′ S, 13° 13′ E	—	—

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